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The Effects of Logging, Other Forest Industries and Forest Management Practices on Fish: An Initial Bibliography

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THE EFFECTS OF LOGGING, OTHER FOREST INDUSTRIES AND FOREST MANAGEMENT PRACTICES ON FISH: AN INITIAL BIBLIOGRAPHY

by

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TABLE OF CONTENTS

	Page
ABSTRACT	iv
INTRODUCTION	1
REFERENCES	10
AUTHOR INDEX	178
STUDY SITE INDEX	193
GEOGRAPHIC INDEX	194
SUBJECT INDEX	196
APPENDIX: OTHER BIBLIOGRAPHIC SOURCES	206

ABSTRACT

Macdonald, J. S., G. Miller, and R. A. Stewart. 1988. The effects of logging, other forest industries and forest management practices on fish: an initial bibliography to 1986. Can. Tech. Rep. Fish. Aquat. Sci. 1622: 212 p.

The bibliography provides a comprehensive list of approximately 1500 references that describe the direct effects of the forest industry on fish and fisheries. Despite its length, the bibliography does not deal fully with all aspects of forest ecology and fish habitat. Topics covered selectively include: water quality, stream channel morphology, streamflow, water supply, forest soils, forest fires, climate, toxicology and pollution. A list of other bibliographic sources in included. Indexes (subject, geographic and study sites) are provided.

RÉSUMÉ

Macdonald, J. S., G. Miller, and R. A. Stewart. 1988. The effects of logging, other forest industries and forest management practices on fish: an initial bibliography to 1986. Can. Tech. Rep. Fish. Aquat. Sci. 1622: 212 p.

La bibliographie fournit une liste détaillée d'environ 1 500 ouvrages qui décrivent les effets directs de l'industrie forestière sur le poisson et sur les pêches. Malgré son ampleur, la bibliographie ne couvre pas tous les aspects de l'écologie forestière et de l'habitat du poisson. Les sujets traités de façon sélective comprennent la qualité de l'eau, la morphologie du lit des cours d'eau, le débit des cours d'eau, l'approvisionnement en eau, les sols forestiers, les incendies de forêt, le climat, la toxicologie et la pollution. On trouve aussi une liste d'autres sources bibliographiques. On fournit des index (sujet, aires géographiques et sites des études).

INTRODUCTION

Interaction is to be expected whenever two resources based industries such as fishing and forestry share the same region. The best timber frequently grows on valley bottoms and alluvial plains, near water courses. Timber is frequently transported by water and therefore the waterways, bays and estuaries, and coastal access areas are in high demand by foresters, fishermen and the fishery resource itself.

Clearly, improper forest practices can reduce fish resource productivity but interaction between the two industries need not be negative. In fact, recent studies suggest that constraints on forestry activities may be unnecessarily restrictive and have demonstrated that logging is not categorically harmful when proper management practices are followed (Salo and Cundy 1987).

The purpose of this bibliography is to provide a comprehensive list of references that describe the direct effects of the forest industry on fish and fisheries. It also provides a more selective list of references that describe the effects of forest harvesting, processing industries and forest management practices on fish habitats. The emphasis of the bibliography is on papers published up to and including 1986. More recent references were included as we became aware of them.

Studies since the 1930s have reflected the concern placed on the effect improper forest practices have on fish resources. Recently, as both fishing and forestry activities have expanded and as it has become evident that resources were finite, long-term (10-20 years), integrated, multidisciplinary case studies have been organized. The case study approach is most appropriate as it provides a more detailed description of forest impacts on fish resources. It promotes an understanding of fish production as it relates to the underlying processes involved in stream production and forest outputs. This bibliography attempts to provide a complete list of papers describing aspects of several large-scale long-term case studies concerning forests and the aquatic environment (e.g. Carnation Creek, Alsea watershed, etc.).

Some of the case studies are not directly concerned with forest management aspects. However, any long-term study that has adopted an ecosystem approach to investigating energy, water or nutrient flow within an entire watershed is of value to a researcher concerned with fishery-forestry interactions (e.g. Experimental Lakes, Hubbards Brook, etc.).

Unfortunately, this bibliography cannot deal fully with all aspects of forest ecology and fish habitat that might be of pertinence to the user of this bibliography. In general, only those papers dealing directly with the interactions of fish and the forest are included. Among the topics dealt with in a selective fashion are:

Water quality
Stream channel morphology
Streamflow, water supply
Forest soils
Fire
Climate
Toxicology
Pollution

The bibliography, also, does not deal with general forest management techniques, watershed management approaches, and general research techniques used to determine interrelationship between fish and forests. References dealing with general aspects of forests. References dealing with general aspects of forest ecology and fish life history also are excluded.

There are a variety of other bibliographic sources and literature reviews that may be consulted to supplement this bibliography. A list of these is appended. Among the most useful of these sources are:

LOGGING: Bell, Brown and Hubbard 1974; Bell, Becket and Hubbard 1976; Blackie, Ford, Horne, Kinsman, Last and Moorhouse 1980.

WATER QUALITY SEDIMENT: Hall 1984; Hall, Haley and Gislason 1984; Iwamota, Salo, Madej, McComas and Rulifson 1978; Whittemore 1984; Muncy, Atchison, Bulkley, Menzel, Perry and Summerfelt 1979; Sorenson, McCarthy, Middlebrooks and Porcelts 1977.

NUTRIENTS: Kimmins, Binkley, Chartarpal and de Catanzaro 1985 (2 bibliographies).

PESTICIDES: Bart and Hunter 1978; Vanden Born and Malik 1984; Malik and Vanden Born 1986.

PULP AND PAPER IMPACTS: D. McLeay and Associates 1987; Hutchins 1977; Poole, Wildish and Kristmanson 1978.

ROADS: Villamere, Stockwell, Dane and Mathers 1983; Shea and Mathers 1978.

STREAM HABITAT AND REHABILITATION: Duff, Gnehm, Shrader and Howard 1986; Rodgers 1985.

FIRE: Feller 1982; Viereck and Schadelmeir 1980.

FOREST MANAGEMENT: Reiser and Bjornn 1979; Chamberlin 1982; Yee and Roelefs 1980; Sedell and Duvall 1985; Everest and Harr 1982; Platts 1981; Martin and Platts 1981; Norris, Lorz and Gregory 1983; Schmiege 1980; Clarke, Gibbons and Pauley 1985; Hall and Baker 1982; Reeves and Roelofs 1982; Huppert, Fight and Everest 1985.

In addition, review essays appearing in the literature review issues of the Journal of the Water Pollution Control Federation provide information on pulp and paper industry effluent management, dissolved oxygen, thermal

effects, effects of pollution on freshwater and saltwater organisms and other associated issues. The Technical bulletin series of the National Council of the Paper Industry for Air and Stream Improvement also provides useful annual reviews (e.g. Ice 1986) as well as special reviews (e.g. Hall 1984).

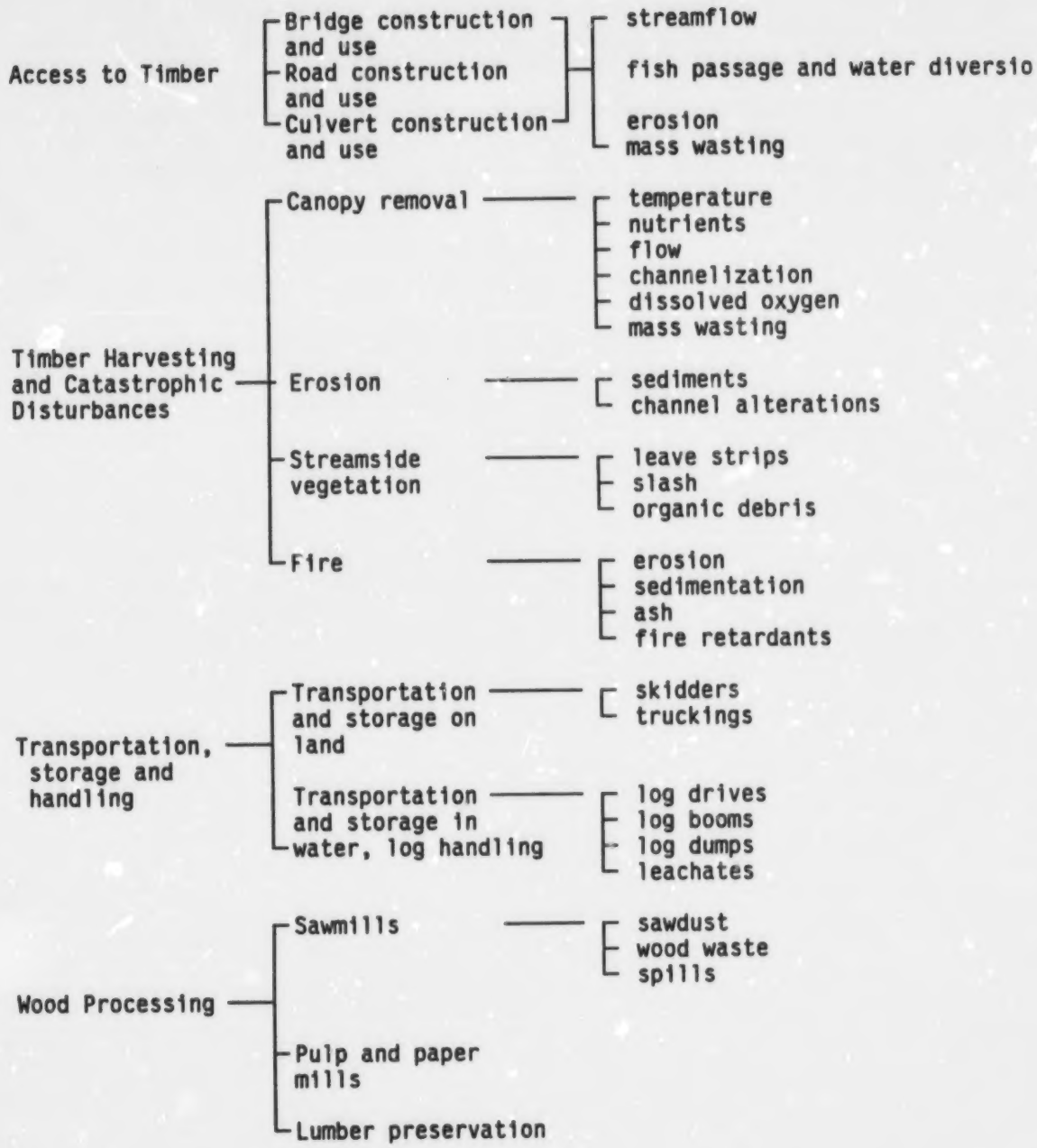
Finally, the proceedings of workshops and seminars provide excellent sources for the review of various aspects of fish forest interactions. The most recent proceedings are of a seminar held in Seattle, Washington in February 1986 (Salo and Cundy 1987).

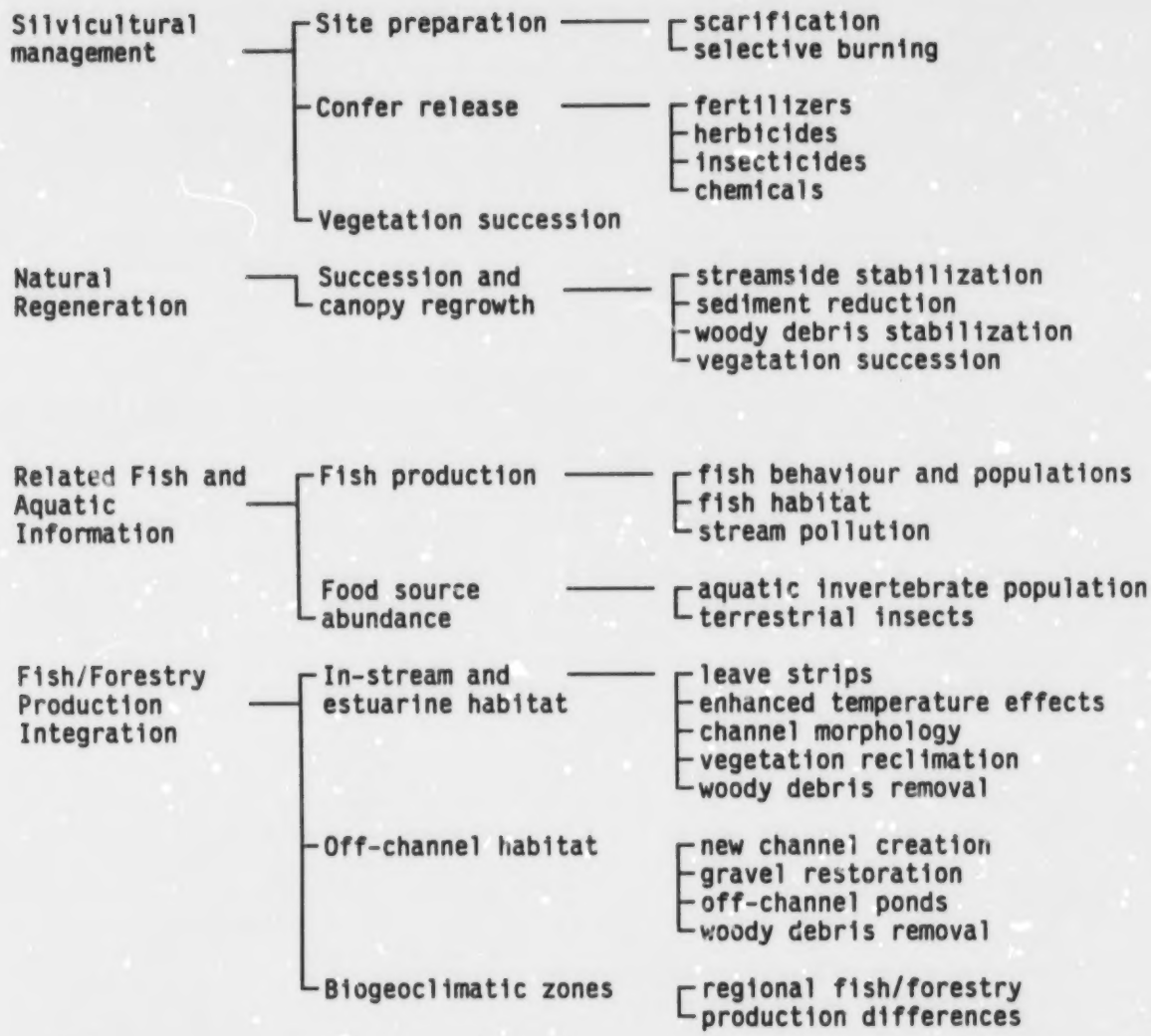
INDEXES

Each of the references was assigned keywords relating to study site geographic location. A separate index for each of these aspects is included in the bibliography.

Subject terms

Although the subject keywords are listed in simple alphabetical order in the index, many of these terms are associated or may be considered as aspects of a more general concept. The list of subject keywords which follows has been organized by topic and subtopic. Some keywords may appear several times. We hope this arrangement will assist you in the use of our subject index.


Access to Timber
Bridge construction and use
Road construction and use
Culvert construction and use
streamflow
fish passage and water diversio
erosion
mass wasting
Timber Harvesting and Catastrophic Disturbances
Canopy removal
temperature
nutrients
flow
channelization
dissolved oxygen
mass wasting
Erosion
sediments
channel alterations
Streamside vegetation
leave strips
slash
organic debris
Fire
erosion
sedimentation
ash
fire retardants
Transportation, storage and handling
Transportation and storage on land
skidders
truckings
Transportation and storage in water, log handling
log drives
log booms
log dumps
leachates
Wood Processing
Sawmills
sawdust
wood waste
spills
Pulp and paper mills
Lumber preservation



Study Sites

We have included a special index to identify those references that are associated with long-term studies involving particular watersheds. Those case histories that we examined are:

A. Hubbard Brook - This study took place in a small watershed (3,300 ha) in the White Mountains of north-central New Hampshire. The Hubbards Brook study was established in 1955 by the U.S. Forest Service to research watershed management. This study used an ecosystem approach over the entire watershed and considered the flux and cycling of energy, water, nutrients and other materials across the ecosystems boundaries and within the system itself.

B. Experimental Lakes Area (ELA) - The experimental Lakes Area is located in northwestern Ontario and is composed of 46 small lakes in 17 localized drainage basins (Johnson and Vallentyne 1971). Studies in this area began in the mid 60s to study the effect of eutrophication on small lakes and to compare this information to the Great Lakes and other Canadian lakes. As such, little work during this study pertained directly to fish-forestry interactions.

However, as large amounts of eutrophication may occur after forest fires or logging (Likens 1985), particularly in watersheds that contain lakes. E.L.A. research should be included with other fishery-forestry interaction literature.

C. Carnation Creek - This study was established in 1970 and continues to be administered by the Department of Fisheries and Oceans in conjunction with MacMillan Bloedel Ltd., B.C. Ministry of Forests and Lands, B.C. Ministry of Environment and Parks and Environment Canada. The study had 3 phases; a 5 year pre-logging study; a 5 year year logging period and a post-logging monitoring phase. Carnation Creek drains into Barkley Sound on the west coast Vancouver Island. The watershed drains an area of 1000 ha and has a flow range from 0.03 to 63 m^3/s. The creek is composed of flood plains, a canyon and an estuary and has sediments that range from boulders and bedrock outcrops (in the canyon) to alluvial sands on the flood plains. There are no lakes in the system. Steep slopes occur frequently within the watershed (40-80%) and therefore many of the Carnation Creek tributaries have steep gradients.

D. Alsea Watershed - This study was established in 1957 and administered by Oregon State University with the Oregon State Game Commission (now the Department of Fish and Wildlife) doing much of the research. Monitoring of physical and biological features began in 1959, logging activities took place from 1965-66 and post logging monitoring continued until the fall of 1973. This study took place in three tributaries, Deer Creek (304 ha), Flynn Creek (203 ha), and the Needle Branch (71 ha) of Drift Creek which flows into Alsea Bay near Waldport on the Oregon coast. This was the first long-term watershed study to consider the impact of timber harvest practices on biological characteristics of streams, including anadromous fish populations, coho salmon and cutthroat trout. One of the three watersheds examined was completely clearcut, a second was patchcut (3 cuts of approximately 25 ha each) with a buffer strip left along the main stream channel and the third remained undisturbed (control area).

E. Nashwaak Watershed - Three small watersheds in central New Brunswick were involved in this study. Pre- and post treatment investigations of the effects of watershed fertilization (1975), clearcutting (1978), and insecticide application (1976). Treated watersheds (Narrows Mountain or Lake Brook) were compared to the control watershed (Hayden Brook). Variables investigated were: climate, water balance, forest soils, nutrient cycling and forest composition, litterfall and regeneration rates.

F. Caspar Creek - This study began in 1966 under the direction of the California Department of Fish and Game. Its purpose was to determine what effects logging and associated road building had on salmonids living in adjacent streams. Four small streams (Caspar Creek, Bummer Lake, Creek, Yager Creek and Noyo River) on the northern Californian coast were chosen for study. Their watersheds have areas that range from 425 to 2,514 ha and have slopes of 36 to 49%. Study section stream gradient range from 3 to 5%. Minimum stream flows range from 1.7 to 14.2 L/sec. All four watersheds were either clearcut or selectively logged. On one stream, buffer strips were left; on another road material was cast into the creek and logs were hauled through it.

G. Clearwater River - The basins of the Clearwater and Queets Rivers and associated tributaries have been the site of a large number of unrelated studies since the early 1970s. They were designed to investigate: a) habitat utilization and growth of coho salmon, cutthroat trout and chinook salmon, b) the effects of large woody logging debris on abundances of salmonids and c) the effects of landslide siltation on salmonids of streams in logged watersheds. Studies have been supported by Washington Department of Fisheries, University of Washington, Washington Department of Natural Resources, USDA, Forest Service and Oregon State University. The Clearwater and Queets watersheds are 375 km^2 and are located on the western slopes of the Olympic Mountains in Jefferson County, Washington. The Queets River is contained within the Olympic National Park. Both rivers have a combined flow range of 2.0 m^3/sec to 860 m^3/sec and an average gradient of 2.4 percent. The river flows through a wide flood plain from which both valley slope tributaries and valley-wall tributaries flow (Sedell et al. 1984). Valley slopes average between 20 and 30 degrees.

H. Tri-Creeks Watershed - This study was initiated in 1965 by the Alberta Department of Lands and Forests with the cooperation of Environment Canada, Alberta Research Council and Universities of Alberta and Calgary and Champion Forest Products (formerly St. Regis Ltd.) for the purpose of evaluating the effects of pulpwood harvesting on the physical, chemical, and biotic qualities of western Alberta trout streams. The study area is situated 40 km southeast of Hinton, Alberta. The three creeks examined in this study (Wampus, Deerlick, and Eunice) are tributaries of the McLeod River which flows into the Athabasca River. The watershed area is 59 km^2 and ranges from 1262 meters to 1707 meters of elevation. All three streams have low gradients (1.9-3.5%) with the steepest gradients occurring at the headwaters. Water temperature, streamflow (including hydrologic pathways), suspended sediments, stream siltation and chemical quality were measured in 3 streams that had each received a different logging treatment. Survival, growth and reproduction of fish and aquatic invertebrate populations were also monitored.

I. Queen Charlotte Islands - This study was initiated in 1981 by the B.C. Ministry of Forests, B.C. Ministry of Environment, and the Canada Department of Fisheries and Oceans. Its purpose is to investigate the effects of steep slope logging on aquatic environments with a view to developing alternate logging techniques, and methods to rehabilitate

disturbed stream and forest sites. The Queen Charlotte Islands, located off the central coast of B.C. form an archipelago with an area of 9940 km^2. The study investigates aquatic resources and logging methods in watersheds in nine different geographic areas on these islands. Information regarding slope failures and success of rehabilitation efforts within each geographic area is currently being collected.

J. Slim-Tumuch Watersheds - This study was initiated in 1971 by the Canada Department of the Environment Fisheries Service (now DFO), Northwood Pulp Ltd. and the British Columbia Fish and Wildlife Branch. Its purpose was to assess the effectiveness of stream protective measures in relation to current forest harvesting practices in the central interior of British Columbia. It was designed to be a short term study (3 years) with data being collected between June and October each year. It was thought that fishery - forestry interaction data from coastal studies would not be entirely applicable to interior watersheds because there are many differences in harvesting methods, soil types, climate and runoff regimes. Slim Creek is located 80 km east of Prince George in the Fraser River drainage system. The study area was 186 km^2 and has a maximum elevation of 885 m. Stream gradients in the study area were small but slopes on the valley sides ranged from 20-30%.

Geographic location

When possible the references were described by the geographical area to which they refer.

Canada
- Atlantic Provinces
- Ontario and Quebec
- Prairie Provinces
- British Columbia

United States
- Alaska
- Northwestern U.S.
- Southwestern U.S.
- Southern U.S.
- Central U.S.
- Northeastern U.S.

Europe
Britain
Scandinavia
USSR
Asia
New Zealand

Biologists and foresters recognize that fishery - forestry information from one study area, while serving as a useful guideline, likely will not be entirely applicable to another area. Forest outputs (water, nutrients and debris) and the effect logging practices have on these outputs are dependent on the latitude, altitude, soil type, drainage area, slope,

climate, developmental status, etc. of the watershed. Therefore strategies used to integrate fishery resources management and forestry practices must be designed with the features of each watershed in mind.

Studies from different geographic areas have taken different approaches. For example, studies from the Pacific northwest of North America and Alaska deal primarily with forest management issues. Studies from the southwestern USA are mostly concerned with water supply issues and those from the southeastern USA are concerned with sportsfish. Much of the fishery-forestry work from the Atlantic provinces is concerned with the impact of forest insecticide programs.

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AUTHOR INDEX

Adams, J.N., 1
Adams, L., 2
Adamus, P., 660
Ahnell, W.H., 925 to 926
Aho, R.S., 3 to 4, 531
Aitken, W.W., 5
Akagi, H., 1469
Alaska Forest Research Center., 6 to 13
Albin, D.P., 14
Albright, L.J., 704
Alderdice, D.F., 15 to 19
Alderton, P., 1482
Allee, B.J., 20
Allen, I.V.F., 21
Allen, K.R., 22 to 23
Amaranthus, M.P., 24
Amberg, H.R., 350, 581
Anas, E., 1041, 1046
Andersen, B.C., 25 to 27, 568, 1001, 1212 to 1213
Andersen, H.E., 28
Anderson, E.P., 29
Anderson, H.W., 30 to 35
Anderson, J.B., 1403 to 1404
Anderson, J.H., 42
Anderson, J.M., 36 to 39, 578
Anderson, J.W., 40 to 41
Anderson, N.H., 42, 550, 986, 1226
Anderson, T.D., 1375
Andrew, F.J., 43
Andrews, A.K., 161
Angermeier, P.L., 44
Angotti, R., 1453
Anonymous., 45 to 67
Armantrout, N.B., 426
Armour, C.L., 68
Armstrong, F.A.J., 69, 1317
Armstrong, R.H., 1128, 1247
Arnold, J.F., 70
Atchison, G.J., 982
Atkinson, S.R., 71
Au, D.W.K., 72
Aubertin, G.M., 73 to 74, 1070
Aumen, N.G., 550, 1437
Austin, R.E., 1307

Bachmann, R.W., 75
Baker, B.L., 1363 to 1367
Baker, C., 76
Baker, C.O., 77, 524 to 525
Baker, S.E., 1346
Bandy, P.J., 78
Barber, W.E., 1057
Barker, J.L., 79
Barr, N.R., 24
Barr, R.M., 820
Bates, C.G., 80 to 81
Beary, K.G., 1200
Bechtel, T.J., 82
Beidler, W.M., 1015
Beil, K.E., 83
Beitz, B.L., 499
Belt, G.H., 1289
Benda, L.E., 84, 1329
Benedict, A.H., 85
Benke, A.C., 86
Berg, R.J., 87, 1206
Berglund, E.R., 88
Bergstrom, G.P., 89
Bermingham, N., 139
Berndt, H.W., 90 to 94
Bernhardt, J., 95, 1385
Berry, J.D., 96 to 97
Beschta, R.L., 1, 98 to 107, 427, 684, 1035, 1073, 1134, 1408 to 1409
Bethalmy, N., 108 to 109
Betts, J.L., 326 to 327
Bevan, D.E., 110 to 111
Bider, J.R., 214
Bietz, B.F., 412 to 413
Bilby, R.E., 103, 112 to 116, 128 to 129, 828
Bills, D.D., 591
Birtwell, I.K., 117 to 121
Bishai, H.M., 122
Bishop, D., 1276
Bishop, D.M., 123 to 127, 932, 1237
Bisson, P.A., 128 to 131, 1217
Bister, H., 1042, 1046 to 1047
Biswell, H.H., 132
Bjornn, T.C., 133 to 136, 676, 1143, 1264, 1358
Black, E.A., 817
Black, P.E., 137
Black, T.A., 276
Blahm, T.H., 138
Blaise, C.R., 139
Blazek, D., 1230

Bloom, A.M., 1244
Blosser, R.O., 140, 1440
Bocsor, J.G., 141
Boehne, P.L., 636 to 637
Bollen, W.B., 1025
Bond, C.E., 706
Bond, L.H., 142
Bonn, E.W., 143
Borchardt, L.G., 374
Bormann, F.H., 144 to 150, 488 to 490, 631 to 632, 698, 829 to 832, 1099 to 1100, 1261, 1461 to 1462
Borton, D.L., 151 to 153
Boschung, H., 154
Bostrom, S.L., 155
Bottom, D.L., 156
Boussu, M.F., 157
Boyonoski, N., 1328
Bradbury, J.P., 158
Brazier, J.R., 159
Breese, W.P., 160
Brett, J.R., 16, 18, 1442 to 1443
Bridges, W.R., 161
Briggs, J.C., 162
British Columbia. Fish and Game Branch., 245
British Columbia. Fish and Wildlife Branch., 246
Brodie, J.M., 163
Brooks, R.R., 164
Brouzes, R.J.P., 165 to 166
Brown, C.B., 167
Brown, D.A., 168, 900 to 902
Brown, G.W., 103, 159, 169 to 186, 526, 784, 1108
Brown, H.E., 187
Brown, J.E., 188
Brown, T.G., 189, 569
Brownlee, M.J., 190 to 192, 573, 1214 to 1215, 1379
Brunskill, G.J., 193 to 194
Brusven, M.A., 135 to 136, 195, 365 to 367
Bryant, M., 196
Bryant, M.D., 129, 197 to 201, 470, 931, 1330, 1336
Buchanan, D.V., 202
Buckner, C.N., 203 to 205
Bugert, R.M., 206
Bulkley, R.V., 982
Bull, C.J., 207 to 208
Bullard, W., 209
Bullard, W.E. Jr., 210
Burdick, G.E., 211 to 212
Burger, K.R., 213
Burgess, S.A., 214
Burgner, R.L., 215
Burnet, A.M.R., 216
Burnham, K.P., 68
Burns, D.M., 780
Burns, J.E., 217
Burns, J.W., 163, 218 to 221, 501, 768
Burridge, L.E., 910
Burroughs, E.R., 222
Burrows, R.E., 290
Burton, D.T., 223, 502
Burton, R.A., 224
Burton, T.M., 225
Busch, D.E., 226
Bustard, D.R., 227 to 232
Butler, R.L., 233

Cairns, I., 756 to 760
Calderwood, H.N., 458
Calhoun, A., 234 to 238
Callahan, C.A., 316
Cameron, J.J., 41
Campbell, A.G., 1332
Campbell, A.J., 239, 1262
Campbell, C.J., 240 to 241
Campbell, G.S., 282
Campbell, H.J., 242 to 243, 527, 1093 to 1094
Can Test Ltd., 244
Canada. Department of Fisheries and Oceans (Scotia-Fundy Region)., 247
Canada. Department of Fisheries., 245 to 246
Canada. Department of the Environment., 248
Canada. Fisheries and Marine Service (Pacific Region). Fisheries Operations Directorate., 249
Cappelli, M., 250
Cardinal, P.J., 251
Caron, A.L., 1440

Carr, W.W., 252 to 253
Carrow, J.R., 254
Carson, C., 275
Carter, N.E., 255
Case, A.B., 256, 889
Casteen, M., 1047
Cederholm, C., 1178
Cederholm, C.J., 257 to 268, 427, 816, 1139, 1193, 1441
Cerezke, H.F., 695
Chacho, E., 136
Chadwick, G.G., 1257
Chalfant, G.R., 222
Chamberlin, T., 1002
Chamberlin, T.W., 269, 1271
Chapman, D.W., 270 to 274, 472
Chavalier, B., 275
Cheng, J.D., 276
Chew, K.K., 1019
Chipman, W.A. Jr., 458 to 459
Chittendon, A.K., 277
Choi, P.M.K., 1509
Choo, A.H., 1454
Christie, G., 332
Christie, P.M., 278
Church, M., 279
Claire, E.W., 1094 to 1095
Clark, W.C., 1445
Clarke, J., 280
Clay, C.H., 281
Cleave, M.L., 514
Cline, R.G., 282
Cline, S.P., 550
Coady, L.W., 283 to 284, 1149
Coats, R., 285
Coble, D.W., 286 to 287
Coghlan, G.T., 1247
Colby, D., 212
Cole, A.E., 288
Cole, D.W., 467
Collins, L., 285
Combs, B.D., 289 to 290
Commandeur, P.R., 1285 to 1286
Conklin, P.J., 291
Conlan, K.E., 292 to 294
Conrad, C.E., 1374
Cook, G.H., 295
Cook, W.H., 296 to 297
Cooper, A.C., 298 to 299
Cope, F.G., 300
Cope, O.B., 301 to 303, 1184 to 1185
Copeland, B.J., 82
Coppage, D.L., 295
Corbett, E.S., 304, 851, 1154
Cordone, A.J., 305 to 306, 423
Corliss, J.F., 274
Cormack, R.G.H., 307
Corriden, F.E., 325
Costerton, J.W., 1363
Cote, Y., 308
Couillard, D., 309
Courtemanche, D.L., 310
Coustalin, J.B., 891
Coutant, C.C., 311
Cowley, L.J., 312
Cramer, O.P., 313
Crandall, A.C., 314
Cromack, K., 1388
Cromack, K. Jr., 550
Cross, S.F., 315, 714 to 715
Crouse, M.R., 316, 1307
Crouter, R.A., 317
Crown, M., 318
Crozier, M.J., 498
Culp, J.M., 319
Cummins, K.W., 320, 550, 1480
Cundy, T.W., 1180

D. McLeay and Associates Ltd., 321
Dacre, J.C., 322
Dalton, J.A., 1200
Dalziel, J.A., 1298
Dane, B.G., 323 to 324
Darnell, R., 660
Darsie, R.F. Jr., 325
Das, B.S., 326 to 327
Datzman, P.A., 1145
Daugharty, D.A., 346 to 347
Davis, G.E., 1229
Davis, J.C., 328 to 333, 1158
Davis, J.T., 334
Davis, M.B., 335
Davis, R.C., 336
Dawson, H.J., 1087
Dean, H.J., 211 to 212
De Leeuw, A.D., 337, 338
Dean, H.J., 211 to 212
DeCalesta, D.S., 542
Demory, R.L., 274, 339
Dennis, H.R., 340
Densen, J.W., 381
DeRoche, S.E., 142

Deschamps, G., 341, 1452
Desi, I.G., 342
Devine, J.M., 343 to 344
de Vries, J., 276
Dewitt, J.W., 345
Dickison, R.B.B., 346 to 347
Dickson, A., 348
Dietrich, J.H., 1374
Dimick, R.E., 349 to 350, 581
Dinneford, B., 351 to 352
Dissmeyer, G.E., 353
Doe, K.G., 1449
Dolloff, C.A., 129, 354, 1325
Dominguez, S.E., 316, 1307
Dominy, C.L., 355
Donaldson, E.M., 370
Dorcey, A.H.J., 356
Doudoroff, P., 350, 594, 706, 1460
Douglas, G.W., 357
Douglass, J.E., 358 to 360
Downing, R.L., 542
Driscoll, C.T., 697
Drooz, A.T., 605
Dryburgh, J.G., 361
Dubowits, D., 362
Duffy, J.R., 1299
Dumouchel, A., 363
Duncan, S.H., 364, 1329
Duncan, W.F.A., 365 to 367
Dunfield, R.W., 858 to 859
Dunford, E.G., 368, 1473
Dunne, T., 1139
Dura, L.G., 342
Durley, K.E., 1276
Duval, W.S., 369, 1218
Dye, H.M., 370
Dykstra, D.P., 371
Dyrness, C.T., 372

E.V.S. Consultants Ltd., 244, 373
Easty, D.B., 374
Eaton, J.S., 148 to 149, 632, 697, 832, 1462
Eccles, B., 549
Echelle, A.A., 1172
Edgington, J., 375
Edgington, J.R., 376 to 377
Edie, B., 1178
Edie, B.G., 260 to 261, 265, 378
Edington, J.M., 503
Edlund, L., 379
Edwards, H.E., 380, 731, 860
Edwards, R.E., 107
Edwards, R.W., 381
Efford, I.E., 382
Eichelberger, J.W., 383
Eidt, D.C., 384 to 389
Eiler, P.D., 967
Elder, J.H., 1230
Eldred, D., 390
Eldridge, W.E., 611 to 612
Ellersieck, M.R., 885
Ellgehausen, H., 391
Elliot, S.T., 470
Elliott, S.T., 392 to 400, 1129 to 1130, 1209
Ellis, D.V., 294
Ellis, M.M., 401
Ellis, R.H., 402, 1229
Ellis, R.J., 403 to 404
Elson, P.F., 405 to 410, 732 to 733, 1299
Endean, F., 695
Engels, J.D., 411
Engle, J.B., 458 to 459
Englert, J., 412 to 413, 499
English, T.S., 414
Epsing, I., 415
Erman D., 416
Erman, D.C., 417, 513, 1010
Ernst, W., 418
Eschner, A.R., 419, 1141 to 1142
Esser, H.O., 391
Estuary, Foreshore and Water Log Handling and Transportation Study., 420
Estuary, Foreshore, and Water Log Handling and Transportation Study. Environmental Review Panel., 421
Evans, W.A., 422 to 424
Everest, F.H., 84, 425 to 430, 542, 1219 to 1220, 1264

F.L.C. Reed and Associates., 373
Faris, T., 1250
Farmer, F.A., 296 to 297
Farr, W.A., 932
Farrington, R.L., 431
Federer, C.A., 432, 629, 633
Feller, M.C., 433 to 435, 737
Fenderson, O.C., 1438
Ferguson, D.E., 436
Ferrell, W.K., 437

Fettes, J.J., 438
Fiance, S.B., 532
Finger, T., 439
Finley, M.T., 702, 1186
Fish, G.R., 440
Fisher, D.W., 698, 830
Fisher, R., 441
Fisher, S.G., 442 to 444
Fisk, L., 445
Flieger, B.W., 446
Flood, K.W., 1465
Florsheim, J., 285
Follis, B.J., 143
Folmar, L.C., 447 to 448
Ford, M.S., 335
Foris, W.J., 875
Forward, C.D., 449
Fox, F.R., 291
Fox, M.E., 450
Franklin, J.F., 550
Fredriksen, R.L., 556
Freedman, B., 451
Freeman, D., 1385
Freese, J.L., 452, 1034
Frey, P.J., 845
Froehlich, H.A., 371, 453 to 455, 1309
Frogatt, J.L., 1221
Froud, G.C., 1419
Futer, P., 761

Gagnon, A., 456 to 457
Gahler, A.R., 181
Galtsoff, P.S., 458 to 459
Gammon, J.R., 460
Gard, R., 461 to 462, 1228
Garman, G.C., 968
Gasser, K.W., 691
Geppert, R.R., 463 to 464
Gerhart, D.Z., 465 to 466
German, E.R., 709
Gerstung, E., 445
Gessel, S.P., 467
Gibbons, D., 1266
Gibbons, D.R., 468 to 471, 1394 to 1395
Gibbs, K.E., 310, 967, 1122
Gibson, H.R., 472
Giger, R.D., 473
Gilbert, J.J., 833
Giles, R.H. Jr., 474
Gilleran, D.J., 475
Gillespie, D.M., 86
Gillis, G.F., 476
Gimbarzevsky, P., 477
Gislason, J.C., 541
Gleason, C.H., 33 to 34, 93
Glenn, S.W., 843
Glickman, A.H., 809
Golden, J.T., 478 to 479
Goodell, B.C., 276, 480 to 481, 848
Goodnight, C.J., 314
Gordon, D.K., 121
Gordon, M.R., 482 to 483, 903 to 905
Gordon, R.W., 484 to 485, 874, 1158, 1231 to 1235
Gosse, J.C., 486
Gosz, J.R., 487 to 490
Graesser, N.W., 491 to 492
Graham, B.W., 193
Graham, J.L., 493 to 494
Graham, R.L., 1331
Grande, M., 495
Grant, C.D., 496
Grant, G.C., 685
Grant, G.E., 497 to 498, 1325, 1329, 1331
Grant, J.W.A., 412 to 413, 499
Gratkowski, H.J., 500
Graves, D.S., 501
Graves, W.C., 502
Gray, J.R.A., 503
Graynoth, E., 504, 962
Greene, A.F.C., 505
Greene, G.E., 506
Greer, G.L., 507 to 508
Gregory, K.J., 509
Gregory, S.V., 510 to 513, 550, 1026, 1224, 1332, 1390
Grenney, W.J., 514
Grette, G.B., 129, 515, 991
Grier, C.C., 516
Griffin, J.M., 517
Griffin, L.E., 518
Grift, N., 841
Gunkel, G., 519
Gurnell, A.M., 509
Guth, J.A., 391

Haak, R.J., 520
Hafele, R.E., 1016
Hagenstein, W.D., 521
Haines, T.A., 522
Hakkari, L., 1268

Halbach, T., 463
Haley, R., 540 to 541
Hall, H., 418
Hall, J.D., 4, 523 to 531, 679, 785, 985, 1152, 1226, 1480 to 1481
Hall, K.J., 382
Hall, L.W., 223
Hall, R.J., 532
Hall, S., 418
Hall, S.E., 533
Hall, T., 534
Hall, T.J., 153, 535 to 541
Halls, L.K., 542
Halsey, T.G., 1030, 1068, 1271 to 1274
Hamilton, R.E., 543
Hanavan, M.G., 2
Hanley, T.A., 934
Hansen, E.A., 544 to 546
Hansen, R., 445
Hansmann, E.W., 547 to 548
Harbo, R.M., 118, 120
Hardcastle, W.S., 334
Harding, E.A., 549
Harding, G.D., 1354
Harding, R.D., 397
Hardy, C.E., 1405
Harlow, R.F., 542
Harmon, M.E., 550
Harper, W.C., 340, 551, 557
Harpham, V.J., 1260
Harr, R.D., 428, 552 to 559
Harris, A.S., 560
Harris, D.D., 561 to 563
Harris, E.J., 211 to 212
Harrold, L.L., 893
Harshbarger, T.J., 542
Hartman, G.F., 564 to 574, 620, 1392
Hartong, A.L., 575
Hasler, A.D., 459
Hatch, R.W., 576
Hatfield, C.T., 577 to 580
Haugen, G.N., 426
Haupt, H.F., 282, 1289
Hawkes, C.L., 953, 1025
Hawkins, C.P., 986
Hawthorne, V.M., 233
Haydu, E.P., 349, 581, 1371
Healey, M.C., 582
Healey, M.C., 582
Heifetz, J., 583 to 584, 699 to 700, 773, 987, 989 to 990
Heller, D.A., 585
Helmers, A.E., 586
Helvey, J.D., 587, 600, 1375
Henderson, C., 588 to 590, 1096
Hendricks, J.D., 591
Hendry, G.R., 532
Henry, A.J., 80 to 81
Henry, R.L., 86
Herbert, D.W.M., 592
Herring L., 1399
Herrmann, R.B., 593 to 594
Hess, L.J., 595
Hesser, R., 596
Hetherington, E.D., 597 to 599
Hewlett, J.D., 600 to 601
Hibbert, A.R., 601 to 602
Hildebrand, L.D., 1324
Hill, C.T., 509
Hillman, G.R., 695, 1339 to 1340
Hiltibran, R.C., 603
Hodges, J.I., 895
Hodgson, G.W., 1363 to 1367
Hoffman, T.C., 604, 1249
Hoffmann, C.H., 605 to 607
Hofstra, T.D., 103, 720
Hogan, D., 608
Hogan, D.L., 609
Hoglund, L.B., 610
Holcombe, E., 1025
Holland, G.A., 611 to 612
Hollender, B., 596
Holmberg, B., 613
Holmbom, B., 614, 1041 to 1043, 1046
Holmes, R.T., 488
Holmes, S.B., 615 to 619, 1328, 1355
Holmgren, S.K., 1199
Holtby, L.B., 103, 570 to 571, 574, 620 to 621
Holtje, R.K., 622
Hooper, D.R., 623
Hoopes, R., 596, 851
Hoover, M.D., 35, 624 to 626, 824
Hopkins, C.L., 627
Hord, H.H.V., 628
Hornbeck, J.W., 629 to 634, 1099, 1320, 1374
Hosley, N.W., 2
Hourston, W.R., 635
House, R.A., 129, 636 to 637
Houston, D.B., 1433
Howard Paish & Associates., 638
Howard, K.M., 988

Howard, K.M., 988
Howard, T.E., 639 to 645, 956, 1198, 1418 to 1419
Howell, P.J., 156
Hoyt, W.G., 646
Hrutfiord, B.F., 1087
Hsieh, F.S., 340, 557, 647 to 648
Hubartt, D., 398 to 399, 649 to 651
Hubartt, D.J., 400
Hug, W.L., 1094
Hughes, G.M., 652
Huizer, E.J., 653
Hulbert, P.J., 654
Hunn, J.B., 1186
Hunt, R.L., 655
Hunter, G.G., 1482
Hunter, R.J., 86
Hursh, C.R., 656
Hutchins, F.E., 657
Huttunen, P., 658
Hutzinger, O., 1509
Hynes, H.B.N., 659
Hynson, J., 660
Hyslop, W.F., 1455 to 1456

Ice, G., 661
Ice, G.G., 662 to 672
Ide, F.P., 673 to 674
Ilnytzky, S., 1150
International Pacific Salmon Fisheries Commission., 245 to 246, 675
Irving, J.S., 676
Iverson, R.A., 677
Iwamoto, R.N., 678
Iwanaga, P.M., 679

J.B. Gilbert Associates., 705
Jablonski, P.D., 680 to 682
Jackson, K.J., 1204, 1377
Jackson, R.G., 683
Jackson, W.L., 104 to 106, 684
Jacobs, F., 685
Jager, E., 379
James, G.A., 28, 686 to 687
Janik, P., 786
Jeffrey, W.W., 688 to 689
Jensen, S., 613
Jepson, M.A., 223
Johansen, P.H., 579
Johansson, R.G., 155
Johnson, D.R., 895
Johnson, D.W., 690 to 691
Johnson, E.A., 692 to 693
Johnson, F.W., 694
Johnson, H.E., 1067
Johnson, H.J., 695
Johnson, J.H., 696
Johnson, J.M., 426
Johnson, N.M., 697 to 698, 830 to 832
Johnson, S., 773
Johnson, S.W., 699 to 700, 987, 989 to 990
Johnson, W.E., 701
Johnson, W.W., 702 to 703
Johnston, B., 424
Johnston, D.W., 2
Johnston, N.T., 704
Jones & Stokes Associates, Inc., 705
Jones, A.C., 1007
Jones, B.F., 350, 706
Jones, W.E., 707
Julin, A.M., 448, 708
June, J.A., 875, 1217

Kabel, C.S., 709
Kaiser, K.L.E., 450, 710
Kajak, A., 711
Kajak, Z., 711
Kalra, Y., 1267
Kanazawa, J., 712
Karanka, E.J., 713
Karko, A., 1307
Karlsson, L., 610
Karlsson, M., 791
Karr, J.R., 44
Kathman, R.D., 714 to 715
Katz, M., 716, 1403 to 1404
Kaufman, D., 285
Keenleyside, M.H.A., 717 to 719
Keller, E., 853
Keller, E.A., 720 to 724
Keller, S.M., 426
Kelley, D.W., 306
Kelly, D.M., 725
Kelso, J.R.M., 726 to 727
Kennedy, H.D., 728
Kerswill, C.J., 406, 729 to 733
Ketcham, D.E., 734 to 735
Kidd, W.J., 942
Kill, A.D., 695

Kimmins, J.P., 736 to 737
Kimura, S., 881 to 882
Kingsbury, A.P., 738 to 739
Kingsbury, P.D., 203 to 204, 616 to 619, 740 to 749, 782
Kirchofer, D., 989
Kirchofer, D.A., 774
Klamt, R.A., 136
Klamt, R.R., 750
Klassen, H.D., 751 to 754
Klauda, R.J., 223
Klingeman, P.C., 784
Knapp, W., 755 to 764
Kneffel, Z., 342
Knight, A.P., 765
Knight, N.J., 528, 766
Knoop, K.D., 106 to 107
Kobayashi, K., 767
Kopperdahl, F.R., 768
Koransky, W., 776
Kosakoski, G., 332
Kosakoski, G.J., 508
Koski, K., 1250
Koski, K.V., 129, 258, 427, 471, 513, 584, 700, 769 to 775, 946, 987, 989 to 991, 1369
Koss, G., 776
Kovner, J.L., 692 to 693
Krag, R.K., 777
Kramer, R.H., 778 to 779, 1279 to 1281
Krammes, J.S., 780
Krause, H.H., 781
Kremer, R.W., 963
Kreutzweiser, D.P., 747 to 749, 782
Kristiansen, D.E., 296 to 297
Kristmanson, D.D., 1110
Kroll, J.C., 542
Kropelin, W., 630
Kruzynski, G., 119, 1041
Kruzynski, G.M., 1158
Krygier, J.T., 182 to 185, 340, 557 to 558, 783 to 785
Kunkel, C., 786
Kunkel, C.M., 843
Kunkle, S.H., 787
Kussat, R., 788

Ladd, J.M., 789
LaHam, Q.N., 883
Lamberti, G.A., 513
Lammel, R.F., 790
Landner, L., 791, 812
Langer, O.E., 792 to 793
Langford, R.R., 794
Lantz, R.L., 526, 529 to 530, 795 to 800, 969 to 970, 1095
Larkin, P.A., 801 to 802
Larmoyeux, J., 419
Larse, R.W., 803
Larson, A.G., 464, 1492
Larson, C.C., 1276
Larson, G.L., 1265
Larson, R., 375
Larsson, A., 613
Lasater, J.E., 611 to 612
Lashmar, M., 762 to 764
Lattin, J.D., 550
Lauman, J.E., 804
Lauzier, L.M., 407
Lawler, T.A., 805
Layton, C., 318
Leach, J.M., 806 to 808
Leach, M.S., 1247
Leahy, R.M., 572
LeBlanc, P.J., 1475
LeBlanc, R., 1475
Lech, J.J., 809, 1306
Lee, R., 810
Lees, J.C., 695
Legault, R., 139
Lehman, C., 811
Lehtinen, K.-J., 614, 812 to 813
Levy, D.A., 820
Lewallen, L.L., 821
Lewander, K., 613
Lewis, D.H., 1252
Lewis, E.H., 1106
Lewis, F.G., 822
Lewis, J.R., 164
Lewis, S.L., 823
Liberman, J.A., 824
Lichatowich, J.A., 1229
Lichtenberg, J.L., 383
Lichtenstein, E.P., 825
Lienkaemper, G.W., 550, 826, 1330, 1333 to 1337
Lembi, C.A., 1230
LeMier, E.H., 814
Lemke, A.E., 1096
Lestelle, L.C., 259 to 262, 815 to 816
Levings, C.D., 190, 817
Levno, A., 818 to 819

Likens, G.E., 116, 146 to 150, 225, 443 to 444, 488 to 490, 532, 631 to 632, 697 to 698, 827 to 833, 949, 955, 1099 to 1100, 1261, 1461 to 1462
Lindgren, S., 834, 1044
Lindsay, R.B., 835
Lindstroem, M., 791
Lindzey, J.S., 542
Lines, I., 1370
Lisle, T.E., 836 to 837, 1325
Lister, N.A., 1470
Livingston, R.J., 838
Loch, J.S., 839 to 840
Lockhart, W.L., 841
Logie, R.R., 842
Loman, A.A., 695
Lonn, B.-E., 951, 1044, 1047
Loper, B.R., 843
Lopushinsky, W., 1161
Lord, D.A., 1449
Lorenz, C.W., 464
Lorenz, J.M., 990
Lorz, H.W., 843, 1026
Lotspeich, F.B., 844 to 845, 933
Love, L.D., 846 to 848
Love, R.J., 960
Lowdermilk, W.C., 849
Lucchetti, G.L., 875
Luchessa, K.J., 1222
Ludke, J.L., 436
Lull, H.W., 1292
Lund, J.A., 850
Lyford, J.H., 1226
Lynch, J.A., 304, 851 to 852, 1154
Lyons, J.K., 1309

McCall, M., 887
McCarthy, M.M., 1293
McComas, R.L., 678
McCorison, F.M., 559
McCraken, F.D., 888
McCubbin, R.N., 889
McCullough, R., 1058
McCullough, R.D., 890
McDaniel, N.G., 817
MacDonald, A., 721 to 723, 853
MacDonald, J.R., 380, 408, 854 to 865, 1085
Macdonald, S.J., 1030
McDowell, W.H., 697
McGreer, E.R., 891 to 892
McGuinness, J.L., 893
McHugh, M.H., 1134
McInerney, J.E., 208
McKague, A.B., 894
McKernan, D.L., 895
MacLeod, J.C., 839 to 840, 1280
MacMillan Bloedel Ltd. Cameron Division., 866
McLeay, D.J., 168, 482 to 483, 642 to 643, 896 to 907
McLeese, D.W., 908 to 911, 1300 to 1302, 1507 to 1508
McLeod, B.B., 203 to 204
McLeod, C.L., 912
McMynn, R., 913
McMynn, R.G., 914
McNeil, W.J., 915 to 926, 1245 to 1246, 1451
McPhee, M.W., 356
McSwain, M.D., 1134
Madej, M.A., 678
Madsen, M.J., 867
Magill, A.R., 868
Mahoney, D., 417, 869
Mahood, H.W., 1158 to 1159, 1233
Mains, E.M.C., 612
Malik, N., 870, 1406
Malueg, K.W., 316, 1307
Mamarbachi, G., 618
Margin, C.W., 1100
Margrey, S.L., 502
Marier, J., 871
Marking, L.L., 872
Marston, R.A., 873
Marston, R.B., 181
Martens, D., 484
Martens, D.W., 874, 1232, 1234 to 1235
Martin, C.W., 632
Martin, D., 1178
Martin, D.J., 260 to 261, 875
Martin, J., 1190
Martin, J.D., 876
Martin, J.L., 877
Martin, J.M., 878
Marzolf, G.R., 879
Mason, B.J., 331, 333
Mason, J.C., 1003
Mathers, J.S., 880
Matheson, R., 418
Matheson, R.A., 1448 to 1449
Mathieu, P., 618
Matida, Y., 881 to 882

Mattice, E.R., 190
Matton, P., 883
Matula, T., 363
Mauck, W.L., 872, 1203, 1488
Maughan, O.E., 884, 1172
Maxwell, J.R., 585
Mayer, F.L. Jr., 885
Mazsa, D.J., 886
Meehan, B., 945
Meehan, W.R., 429 to 430, 470 to 471, 927 to 937, 1216
Megahan, W.F., 938 to 943, 1104 to 1105, 1144, 1329, 1374
Meginnis, H.G., 944
Meister, A.L., 409
Menzel, B.S., 982
Merilainen, J., 658
Merkenks, J.C., 592
Merrell, T., 945
Merrell, T. Jr., 946
Merrell, T.R. Jr., 471, 934
Merritt, N.J., 723
Messer, J.B., 1347
Metcalfe, C.D., 910 to 911
Metner, D.A., 841
Metsker, H.E., 947
Meyer, F.P., 948
Meyer, J.H., 542
Meyer, J.L., 949
Mian, L.S., 976
Middelraad, I., 950, 1475
Middlebrooks, E.J., 1293
Miettinen, V., 951
Mih, W.S., 952
Miller, R.A., 953
Miller, W.J., 275
Milligan, J.H., 136
Millikin, R.L., 619
Minns, C.K., 727
Minshall, G.W., 1105
Miyamoto, J., 954
Moeller, R.E., 955
Molitor, D.E., 943
Molnau, M., 135
Molnau, M.P., 136
Monteith, D.D., 956
Montgomery, M.L., 1027
Moore, D.G., 957 to 959, 1025, 1028
Moore, D.J., 1230
Moore, J.C., 295
Moore, J.E., 960
Moore, M.K., 961, 1380 to 1381
Moore, R.B., 696
Morely, R.L., 981
Morgan, D.R., 962
Morgan, L.S., 963
Moring, J.R., 202, 964 to 970, 1095
Morley, R.L., 1136
Morrison, B.R.S., 971
Morrison, D., 972
Morrison, D.C., 191, 573
Morry, C.J., 1190
Mortensen, E., 973
Mortensen, K.L., 203
Morton, W.M., 974
Moses, C., 720
Mosley, M.P., 975
Mueller, E.W., 845, 933
Mulla, M.S., 976
Mullen, D.M., 968
Muller, K., 977 to 980
Mullett, R.G., 981, 1136
Muncy, R.J., 982
Munday, D.R., 892
Mundie, J.H., 1003
Munns, E.N., 983
Munro, J.R., 906 to 907
Murgatroyd, A.L., 984
Murphy, M., 773
Murphy, M.L., 129, 470, 513, 531, 584, 985 to 991
Myren, R.T., 992, 1078

Naish, V.A., 166
Nakari, T., 1043, 1047 to 1048
Nanaimo Estuary Fish Habitat and Log Management Task Force., 993 to 995
Narver, D.W., 231 to 232, 996 to 1003, 1447
Neaves, P.I., 1004
Nece, R.E., 1005
Needham, P.R., 1006 to 1007
Negus, M.T., 967, 1008
Neilson, D.R., 135
Nelles, S., 120
Nelson, H., 1323
Nelson, K.L., 884
Nelson, T., 1370
Netboy, A., 1009
Neumann, E.D., 611
Newbold, J.D., 416, 1010
Newbury, R.W., 1200
Newcombe, C., 1011

Newcombe, C.P., 621
Newton, M., 1012 to 1013
Ney, J.J., 884
Nickelson, T.E., 426, 1014 to 1016
Nikinmaa, M., 1017, 1044
Noggle, C., 1018, 1178
Noggle, C.C., 262
Nordin, J., 791
Norgren, J.A., 1013
Norman, K.E., 1019
Norris, L.A., 843, 935, 953, 1020 to 1028
Northcote, T.G., 704, 754, 820, 1029 to 1030
Northern Forest Experiment Station., 1031 to 1033
Notini, M., 812
Nott, R., 1327 to 1328
Nuss, M.E., 1247

O'Clair, C.E., 452, 1034
O'Connor, T.F., 141
O'Leary, S.J., 107, 1035
O'Loughlin, C.L., 1036, 1074
O'Neal, G.L., 1037
O'Neil, P., 154
Ohls, K., 1038
Oien, W.E., 1039
Oikari, A., 813, 834, 951, 1040 to 1045
Oikari, A.O.J., 1017, 1046 to 1048
Oloffs, P.C., 704
Olson, L.E., 1283
Olson, S.T., 1248 to 1249
Olsson, G., 415
Olsson, M., 613
Orchard, R.D., 931
Oregon State Game Commission., 1049 to 1050
Osborn, J.G., 1051 to 1053
Osborne, J., 418
Oseid, D.M., 1281 to 1283
Ossiander, F.J., 604
Ostroumova, I.N., 1054
Oswald, E.T., 1055 to 1056
Oswood, M.E., 1057
Ott, F.T., 1058
Ottens, J., 1059 to 1060
Ouellet, D.C., 1101
Owens, E.L., 1383, 1440

Paasivirta, L., 1061
Packer, P.E., 1062 to 1065
Palenski, J.R., 1258
Paransovich, M.P., 1250
Parante, W.D., 426
Park, B.C., 303
Parker, R.R., 1066
Parker, W.R., 1450
Parkhurst, Z.E., 1067
Parkinson, E.A., 1068
Parsons, M., 585
Patric, J.H., 73 to 74, 932, 1069 to 1070
Patrick, K., 326 to 327
Patridge, D.B., 852
Patton, D.R., 1071
Paul, R.M., 1072
Paustian, S.J., 1073
Pearce, A.J., 1036, 1074
Pearson, T.H., 1075
Pease, B.C., 1076
Peer, D.L., 1077
Pekovich, A.W., 1247
Pella, J.J., 1078
Pennell, J.T., 1079
Penney, G.H., 278, 861 to 865, 1080 to 1085
Perry, L.C., 982
Peters, G.B., 1086 to 1087
Peterson, K., 788
Peterson, M.R., 39
Peterson, N.P., 263
Peterson, R.H., 1088
Phillips, R.W., 274, 1089 to 1095
Phinney, H.K., 548
Pickering, Q.H., 588 to 590, 1096
Pierce, R.H. Jr., 1097
Pierce, R.S., 149, 631 to 633, 698, 830 to 832, 1098 to 1100
Plamondon, A.P., 1101
Platts, W.S., 68, 1102 to 1106
Pollock, R.D., 1238
Ponce, S.L., 1107 to 1108
Pond, S.G., 1109
Poole, N.J., 1110, 1469
Porcella, D.B., 514, 1293
Porter, P.E., 931
Post, G., 1111
Poulin, V.A., 1112 to 1113
Povoledo, D., 193
Powell, G.R., 1114 to 1119
Powell, J.M., 695

Powell, L., 574
Power, G., 1295
Prather, J.W., 436
Prather, K.V., 195
Praveza, J., 95
Pritchard, A.L., 1120
Prokopowich, J., 1200
Purvis, B., 1385
Putnam, T.P., 591

Quayle, D.B., 1121
Quenet, R.V., 318

Rabeni, C.F., 1122 to 1123
Ramberg, L., 1124
Randall, D.K., 347
Ray, D.G.H., 203
Redding, J.M., 1125
Reed, J., 363
Reed, R.D., 1126 to 1130, 1247
Reed, R.J., 1131 to 1132
Reeves, C.C., 1100
Reeves, G.H., 1133 to 1135
Reeves, R.D., 164
Reid, D.S., 1136
Reid, J., 296 to 297
Reid, K., 296 to 297
Reid, L., 1178
Reid, L.M., 264 to 266, 1137 to 1139, 1325, 1329
Reid, S.G., 326 to 327
Reinhart, K.G., 35, 634, 1140 to 1142
Reiser, D.W., 1143
Rice, R.M., 24, 186, 1144 to 1146
Rich, L.R., 1147
Richard, J.B., 1148
Richardson, L.B., 502
Riche, L.G., 580, 1149
Richmond, H.A., 1150
Ringler, N., 1151
Ringler, N.H., 1152
Rinne, J.N., 1153
Rishel, G.B., 1154
Ritchie, A.R., 627
Ritchie, J.C., 1155
Roach, C.J., 1338
Roberts, B., 1156
Roberts, L.M., 42
Robinson, J., 1457
Roby, K.B., 416, 1010
Rodgers, C.A., 1157
Rodgers, J.D., 156
Roelofs, T.D., 1135, 1500
Rogers, I.H., 119, 1158 to 1159, 1233
Rood, K.M., 1160
Rosgen, D., 1341
Rothacher, J., 556, 818 to 819, 1161
Rothacher, J.S., 1144, 1162 to 1165
Rothwell, R.L., 1166 to 1167
Row, R., 1168
Rowbottom, R., 296 to 297
Rowe, D.A., 256, 889
Rowe, L.K., 1074
Rowe, L.W., 1169 to 1170
Rowe, P.B., 1171
Rudd, J., 1060
Ruggles, C.P., 1303 to 1304
Rulifson, R.L., 678
Russell, P.A., 381
Ruszcynski, T., 1200
Rutherford, D.A., 1172
Ryan, M.W., 1285 to 1286

S. Sydneysmith & Associates Ltd., 1173 to 1174
Sabean, B., 1175 to 1176
Sacher, R.M., 1177
Salo, E., 1178
Salo, E.O., 260 to 262, 265 to 268, 678, 875, 1179 to 1180, 1395, 1441
Sams, R.E., 1181
Samuel, D.E., 810
Samuelson, C.E., 1182
Sanborn, J.R., 1183
Sanders, H.O., 448, 703, 708, 1184 to 1186
Sanders, P.R.W., 1187
Sandine, M.F., 135
Sarkka, J., 1061
Sarrazin, R., 205
Sartz, R.S., 1386
Sauder, E.A., 777
Saunders, J.W., 409 to 410, 1188 to 1192
Saunders, R.L., 409, 1445
Savina, M.E., 431
Scarlett, W.J., 268, 1193
Scarnecchia, D.L., 1194
Schandelmeier, L.A., 1415
Schaumburg, F.D., 494, 1195 to 1198

Schaye, C., 136
Schindler, D.R., 1199 to 1200
Schindler, D.W., 69, 194
Schmiege, D.C., 1201
Schneider, P.W., 1202
Schoettger, R.A., 1203
Schouwenberg, W.J., 1204
Schreck, C.B., 1125
Schroeder, T.R., 1111
Schulenburg, R.W., 423
Schultz International Ltd., 1205
Schultz, A.M., 132
Schultz, R.D., 87, 1206
Schulz, K.R., 825
Schuytema, G.S., 1207
Schwab, J.W., 1208
Schwan, M.W., 1209
Scott, D., 322
Scott, V.E., 542
Scrivener, J.C., 427, 568, 571, 573 to 574, 1210 to 1215
Sears, H.S., 935, 1216
Sedell, J.R., 42, 84, 129 to 131, 426 to 427, 513, 550, 936, 1217 to 1227, 1330, 1332, 1337, 1389 to 1390
Seegrist, D.W., 1228
Seehorn, M.E., 359
Seeley, C., 238
Seim, W.K., 1229, 1252 to 1253, 1440
Selcher, J., 596
Sergeant, D.B., 910 to 911, 1508
Sergeant, M., 1230
Servizi, J.A., 485, 874, 1158, 1231 to 1235
Shand, I.G., 332 to 333
Shank, G.W., 94
Shankland, R.D., 1207
Shapley, S.P., 126, 1236 to 1237
Shea, M.S., 167
Shelton, J.M., 1238
Shepherd, B.G., 192
Sheridan, W.L., 604, 1239 to 1251, 1276
Shirazi, M.A., 1106, 1252 to 1253
Shortreed, K.R.S., 1318 to 1319
Shortreed, K.S., 1254 to 1255
Shumway, D.L., 1256 to 1258
Sibert, J., 1066
Sibert, J.R., 1259 to 1260
Siccama, T.G., 149 to 150, 1261, 1287, 1461 to 1462
Sidle, R.C., 239, 1262
Sigler, J.W., 1263 to 1264
Silsbee, D.G., 1265
Simpson, B., 1266
Singh, T., 1267
Sinnhuber, R.O., 591
Sipponen, M., 1268
Skaugset, A.E. II., 1269
Skea, J., 212
Skrenteny, R.F., 825
Slaney, P.A., 1068, 1270 to 1274, 1435 to 1436
Smedley, S.C., 1275 to 1276
Smith, B.D., 1277
Smith, D.W., 74
Smith, G.E., 163, 768
Smith, H.A., 1272, 1274
Smith, J., 1278
Smith, L.L. Jr., 778, 779,1279 to 1283
Smith, M., 20
Smith, M.W., 1191 to 1192, 1284
Smith, R.B., 1285 to 1286
Smith, W.H., 1287
Smoker, W.A., 404
Snickars-Nikinmaa, B., 1047
Snyder, G.G., 1288 to 1289
Snyder, R., 596
Society of American Foresters, Columbia River Section, Water Management Committee., 1290
Soivio, A., 1045
Sollins, P., 550
Solly, S.R.B., 627
Sopper, W.E., 304, 852, 1291 to 1292
Sorensen, D.L., 1293
Sorensen, L., 791
Sorensen, J., 1294
Sorensen, L., 791
Sowden, T.K., 1295
Speaker, R.W., 1227
Sprague, J.B., 409, 1296 to 1304
Stainton, M.P., 193
Stallings, D.L., 1157
Stanley, J.G., 890, 1058, 1122 to 1123, 1305
Statham, C.N., 809, 1306
Stay, F.S., 1307
Stefanich, F., 1308
Steinblums, I., 1309
Steinblums, I.J., 1310

Stellako River Log Drive Technical Subcommittee., 1311
Stephens, F., 1276
Sterling, G., 1312 to 1314
Sterling, G.L., 1315
Stevens, M.E., 127
Stevens, N., 1316

Tally, T., 722 to 724
Tanaka, H., 881 to 882
Tappel, P.D., 1358
Tarapchak, S.J., 158
Tarrant, R.F., 1359
Tarzwell, C.M., 589 to 590
Tate, P.S., 202
Tautz, A.F., 1273
Taylor, V.R., 1360
Tebo, L.B. Jr., 1361 to 1362
Telang, S., 1363
Telang, S.A., 1364 to 1367
Terich, T., 1368
Ternan, J.L., 984
Tetreult, B., 308
Thakore, A.N., 806 to 808
Thedinga, J., 773
Thedinga, J.F., 987, 989 to 991, 1369
Theurer, F.D., 1370
Thomas, R.B., 186
Thomas, T., 445
Thut, R.N., 1371
Tibbetts, S., 660
Tiedemann, A.R., 1372 to 1375
Tilley, F.B., 1145
Tinnery, E.R., 877
Titcomb, J.W., 1376
Todd, I.S., 1377
Toews, D.A.A., 1378 to 1382
Tokar, E.M., 1383
Tolonen, K., 658
Toney, R.D., 1384
Townsend, M.A., 222
Tracy, H., 95
Tracy, H.B., 1385
Trial, J.G., 1305
Trimble, F.R., 1386
Trimble, G.R. Jr., 1142, 1387
Triska, F.J., 42, 1225 to 1226, 1388 to 1390
Troendle, C.A., 1391
Troxell, H.C., 646
Tschaplinski, P.J., 1392
Tsukano, Y., 825
Tsumura, K., 704
Tully, J.P., 1393
Tyler, R.W., 1394 to 1395

U.S. Bureau of Commercial Fisheries., 1396
U.S. Federal Water Pollution Control Administration, 1397
University of Washington. Fisheries Research Institute., 1398
Utziq, G., 1399

Vallentyne, J.R., 701
Van Groenewoud, H., 1400
Van Horn, W.M., 1401 to 1404
Van Meter, W.P., 1405
Vanden Born, W.H., 870, 1406
Vander Wal, J., 1407
Vansickle, J., 1408 to 1409
Varty, I.W., 1410 to 1412
Vaughan, D., 1450
Vaux, W.G., 1413
Velsen, F.P.J., 17
Vernon, E.H., 317
Verry, E.S., 1414
Victor, D.M., 1097
Viereck, L.A., 1374, 1415
Vigers, G.A., 891
Virtanen, E., 1047
Vladykov, V.D., 1416

Wabers, B.A., 374
Waddington, C.B., 158
Wade, D.D., 1374
Wald, A.R., 1417
Walden, C.C., 643 to 645, 906 to 907, 1198, 1418 to 1419
Waldichuk, M., 714 to 715, 892, 1420 to 1431
Wallace, R.L., 135
Wallen, E.I., 1432
Wallis, J.R., 1146
Walsh, D.F., 728
Walter, R., 775
Walton, J.M., 1433
Wan, M.T.K., 1434
Ward, B.R., 1435 to 1436
Ward, G.M., 1437
Ward, J.W., 364
Warner, K., 1438

Warren, C.E., 350, 594, 706, 1439 to 1440
Warren, C.M., 1460
Washington State Pollution Control Commission, 1397
Wasserman, L.J., 1441
Watts, F.J., 135
Webb, P.W., 1442 to 1443
Webb, W.L., 1025
Weber, P.K., 1444
Wedemeyer, G.A., 1445
Weirich, C.B., 596
Weisgerber, J.E., 1251
Weiss, C.M., 1446
Weitzman, S., 1387
Welch, H.E., 1447
Wellburn, G.V., 777
Wells, D.E., 971
Wells, P.G., 1448 to 1450
Wells, R.A., 1451
Wendler, H.O., 1452
Werner, A.E., 1453 to 1457
Werner, R., 439
Wesche, T.A., 224
Wesen, C., 1458
West, J.L., 517
White, S.T., 875
Whitehead, V.M., 1459
Whitmore, C.M., 1460
Whitney, R.R., 1087
Whittaker, R.H., 150, 1461 to 1462
Whittemore, R.C., 1463 to 1464
Whittle, D.M., 450, 1465
Wickett, W.P., 18, 1466
Wilder, W.H., 821
Wildish, D.J., 1110, 1467 to 1470 1509
Wilford, D., 1382
Wilford, D.J., 1187
Willcox, H.H. III., 344
Williams, R.C., 563, 1471
Williams, R.E., 612
Williams, R.H., 843
Willingdon, R.P., 276
Willis, M.J., 1015
Wilm, H.G., 1472 to 1473
Wilson, C.N., 1251, 1474
Wilson, M.A., 363, 950, 1475
Wilson, R., 418
Wilson, R.C.H., 1476 to 1477
Wilson, R.L., 1478
Wilzbach, M.A., 1479 to 1481
Winterbourn, M.J., 1482
Woelke, C.E., 1483 to 1487
Wood, J.P., 436
Wood, J.P., 436
Wood, M., 121
Woodward, D.F., 1488
Wooldridge, D.D., 1489 to 1492
Worley, D.P., 1493
Worthington, M.E., 19
Worthington, R.E., 1494
Wright, B.S., 1495
Wright, R.F., 158, 1496 to 1497
Wustenberg, D.W., 1498
Wydoski, R.S., 1499

Yee, C.S., 1500
Yokote, M., 881 to 882
Yuska, J.E., 1227

Zach, L.W., 1501 to 1504
Zegers, P., 1505
Ziemer, R.R., 24, 1329
Zitko, V., 407, 409 to 410, 910 to 911, 1506 to 1509

STUDY SITE INDEX

Alsea Watershed (Oregon), 72, 98, 100, 159, 169 to 172, 175, 181 to 182, 184 to 185, 242, 270, 273 to 274, 286 to 287, 339, 475, 526, 528 to 530, 547 to 548, 551, 557 to 558, 561 to 563, 622, 647 to 648, 766, 769, 784, 797, 835, 964 to 965, 969 to 970, 1035, 1073, 1092 to 1095, 1107 to 1108, 1151 to 1152, 1180, 1408, 1471

Carnation Creek (Vancouver Island), 25 to 27, 227 to 228, 337, 338, 361, 449, 565 to 574, 598 to 599, 620 to 621, 866, 998, 1001 to 1002, 1004, 1055 to 1056, 1060, 1180, 1205, 1210 to 1215, 1254 to 1255, 1318 to 1319, 1351 to 1353, 1380 to 1381, 1392

Caspar Creek (California), 220 to 221, 501, 709, 780, 1145

Clearwater River (Washington), 258 to 260, 262, 264 to 268, 341, 378, 541, 769, 771, 878, 1137 to 1138, 1178, 1180, 1193, 1217, 1227, 1335, 1356 to 1357, 1433, 1441

Experimental Lakes Area (Ontario), 69, 193 to 194, 701, 1199 to 1200, 1317

Hubbard Brook (New Hampshire), 113, 116, 144, 146 to 150, 225, 277, 335, 432, 442 to 444, 465 to 466, 487 to 490, 532, 629 to 632, 697 to 698, 827, 829 to 833, 886, 949, 955, 1099 to 1100, 1261, 1287, 1461 to 1462

Nashwaak Watershed (New Brunswick), 61, 63, 346 to 348, 384 to 389, 781, 876, 1114 to 1119

Queen Charlotte Islands (British Columbia), 229, 253, 279, 477, 549, 713, 751 to 754, 777, 1112 to 1113, 1156, 1160, 1187, 1208, 1285 to 1286, 1382

Slim-Tumuch Watersheds (British Columbia), 192, 1068, 1270 to 1274

Tri-Creeks Watershed (Alberta), 89, 680 to 682, 1267, 1312 to 1316, 1339 to 1340

GEOGRAPHIC INDEX

Alaska, 6 to 13, 28, 56, 58 to 59, 83, 87, 110 to 111, 123 to 127, 197 to 199, 201 to 202, 239, 251, 345, 351 to 352, 354, 365 to 367, 377, 392 to 394, 396 to 400, 403 to 404, 468 to 469, 471, 560, 583 to 584, 604, 649 to 651, 653, 686 to 687, 700, 738 to 739, 772 to 775, 811, 837, 844 to 845, 916 to 930, 932 to 935, 945 to 946, 987 to 992, 1005, 1031 to 1033, 1038, 1076, 1078, 1126 to 1132, 1179 to 1180, 1201, 1206, 1209, 1216, 1223, 1236 to 1237, 1240 to 1251, 1262, 1266, 1275 to 1276, 1330, 1336, 1342 to 1343, 1358, 1369, 1384, 1394 to 1396, 1415, 1444, 1451, 1474, 1501 to 1504

Asia, 712, 881 to 882

Atlantic Provinces (Canada), 37, 50, 61, 63, 255 to 256, 278, 283 to 284, 312, 346 to 348, 380, 384 to 389, 405 to 406, 408 to 410, 412 to 413, 418, 438, 446, 451, 476, 496, 533, 577 to 580, 616, 619, 628, 673 to 674, 717 to 719, 725, 729 to 733, 745 to 746, 779, 781, 842, 854 to 865, 876, 888 to 889, 911 to 912, 1080 to 1085, 1109, 1114 to 1120, 1149, 1168 to 1170, 1175 to 1176, 1188 to 1191, 1296 to 1299, 1302, 1328, 1348 to 1350, 1354, 1360, 1400, 1410 to 1412, 1447 to 1450, 1467, 1469 to 1470, 1477, 1495, 1506 to 1508

Britain, 491 to 492, 503, 640, 971, 1075, 1277

British Columbia, 16 to 19, 21, 23, 25 to 27, 29, 52 to 55, 66, 117 to 121, 139, 145, 168, 189 to 192, 195, 207 to 208, 217, 227 to 232, 244 to 246, 248 to 249, 252 to 254, 276, 279 to 281, 292 to 294, 298 to 300, 317 to 319, 321, 323 to 324, 328 to 333, 337, 338, 356 361 to 362, 369, 373, 382, 421 to 422, 433 to 435, 449, 482, 508, 543, 549, 564 to 568, 570 to 572, 574, 581 to 582, 597 to 599, 608, 620 to 621, 635, 639, 641 to 643, 675, 688 to 689, 704, 711, 713, 734 to 737, 751 to 764, 777, 788, 792 to 793, 801 to 802, 806 to 808, 820, 866, 874, 891, 894, 896 to 898, 900 to 907, 913 to 914, 949, 961, 981, 993 to 995, 997 to 998, 1000 to 1004, 1029 to 1030, 1055 to 1056, 1059 to 1060, 1066, 1068, 1072, 1079, 1112 to 1113, 1121, 1136, 1150, 1156, 1158 to 1160, 1173 to 1174, 1180, 1187, 1198, 1201, 1204 to 1205, 1208, 1210 to 1215, 1234 to 1235, 1254 to 1255, 1259 to 1260, 1270 to 1274, 1285 to 1286, 1294, 1311, 1318 to 1319, 1323 to 1324, 1351 to 1353, 1377 to 1382, 1392 to 1393, 1399, 1415, 1419 to 1422, 1424 to 1431, 1434 to 1436, 1442, 1455, 1457

Europe, 250, 342, 519, 550, 776, 1101, 1177

New Zealand, 22, 164, 216, 322, 440, 504, 627, 962, 975, 1074, 1482

Ontario and Quebec, 36, 69, 165 to 166, 193 to 194, 203 to 205, 308, 418, 456, 483, 616 to 618, 701, 710, 726 to 727, 740 to 743, 747 to 749, 782, 794, 871, 880, 950, 960, 1199 to 1200, 1317, 1407, 1416, 1465, 1475, 1495

Prairie Provinces (Canada), 89, 203 to 205, 336, 357, 659, 680 to 682, 695, 839 to 841, 1166 to 1167, 1267, 1312 to 1316, 1339 to 1340, 1363 to 1367, 1406, 1423, 1459

Quebec and Ontario, 457

Scandanavia, 379, 415, 495, 658, 791, 812, 834, 977 to 980, 1017, 1040 to 1048, 1061, 1124, 1268

United States, Central, 2, 44, 70 80 to 81, 90 to 91, 93, 102, 108 to 109, 137, 158, 161, 200, 241, 275, 288, 301 to 303, 353, 480 to 481, 486, 514, 550, 603, 646, 655, 708, 778, 809, 846 to 848, 850, 872, 974, 1062, 1071, 1103, 1105, 1172, 1308, 1405, 1414 to 1415, 1472 to 1473, 1488, 1496 to 1497

United States, Northeastern, 73 to 74, 79, 85, 113, 116, 141 to 142, 144 to 150, 223, 225, 277, 304, 309, 325, 335, 343 to 344, 350, 359 to 360, 374, 419, 432, 439, 442 to 444, 450, 459, 465 to 466, 474, 487 to 490, 493 to 494, 532, 538, 544 to 546, 550, 588 to 589, 596, 602, 605 to 607, 629 to 633, 654, 660 to 664, 666, 696 to 698, 810, 827 to 833, 884, 886, 890, 893, 955, 963, 967 to 968, 1008, 1058, 1069 to 1070, 1096, 1098 to 1100, 1123, 1140 to 1142, 1230, 1261, 1287, 1305, 1320, 1347, 1401 to 1402, 1438, 1461 to 1462

United States, Northwestern, 1 to 4, 20, 24, 31 to 35, 40 to 41, 43, 70 to 72, 75 to 77, 84, 88, 92 to 101, 103 to 109, 115, 128 to 131, 134 to 136, 153, 156, 159 to 161, 169 to 183, 185 to 188, 196, 209, 215, 222, 240, 242 to 243, 257 to 274, 282, 286 to 287, 313, 316, 339 to 341, 349, 364, 368, 371, 376, 378, 390, 402, 411, 414, 422, 424 to 430, 437, 441, 453, 455, 463 to 464, 472 to 473, 475, 485, 497, 500, 510 to 512, 515, 521, 524 to 531, 534 to 537, 539 to 541, 547 to 548, 550 to 559, 561 to 563, 581, 585, 587, 590, 593, 611 to 612, 622, 636 to 637, 647 to 648, 657, 676, 678 to 679, 684, 702, 716, 750, 766, 769 to 771, 783 to 786, 789 to 790, 795 to 800, 803 to 805, 814 to 816, 818 to 819, 826, 835, 843, 853, 868, 875, 877 to 878, 887, 895, 915, 937 to 943, 952, 957 to 959, 964 to 966, 969 to 970, 985 to 986, 1012 to 1013, 1015, 1018, 1020 to 1028, 1035, 1039, 1049 to 1053, 1072 to 1073, 1086 to 1087, 1089 to 1095, 1102, 1104, 1107 to 1108, 1125, 1133 to 1135, 1137 to 1139, 1143, 1151 to 1152, 1161 to 1165, 1178, 1180 to 1183, 1193 to 1197, 1201, 1207, 1217 to 1218, 1221 to 1227, 1229, 1238 to 1239, 1256 to 1258, 1263 to 1264, 1269, 1278, 1288 to 1291, 1307, 1309 to 1310, 1321 to 1322, 1325 to 1326, 1329, 1331 to 1335, 1337 to 1338,

1341, 1344 to 1345, 1356 to 1357, 1368, 1371 to 1375, 1383, 1385, 1388 to 1390, 1397, 1408 to 1409, 1415, 1417, 1433, 1440 to 1441, 1452, 1471, 1478 to 1479, 1483 to 1486, 1490 to 1492, 1494, 1498, 1500, 1505

United States, Southern, 64, 86, 140, 151 to 154, 241, 295, 498, 517, 534, 550, 646, 661 to 666, 692, 821, 838, 948, 1010, 1097, 1172, 1265, 1346 to 1347, 1361 to 1362, 1463

United States, Southwestern, 14, 46 to 49, 64, 82, 163, 213, 218 to 221, 234 to 238, 241, 305 to 306, 416 to 417, 422 to 423, 431, 445, 501, 550, 595, 705, 707, 709, 721, 723 to 724, 768, 780, 848, 867, 869, 972, 1007, 1036, 1071 to 1072, 1145, 1147 to 1148, 1153, 1171, 1228, 1437

USSR, 1054

SUBJECT INDEX

Access to Timber, 24, 28, 31, 51, 57, 62, 75, 88, 111, 115, 147, 163, 179, 213, 252, 256, 265 to 267, 271, 336, 340, 351 to 352, 364, 368, 376, 392, 398 to 399, 412 to 413, 427, 451, 475, 491, 526, 529, 542, 557, 595, 604, 629, 647 to 651, 660, 709, 780, 803 to 804, 889, 939, 942, 1049, 1059 to 1060, 1063 to 1065, 1102, 1137 to 1139, 1144 to 1145, 1166, 1169 to 1170, 1178, 1180, 1209, 1247, 1270 to 1271, 1343, 1379, 1386 to 1387, 1417, 1447, 1458 to 1459, 1478, 1489 to 1492, 1498, 1500

Aquatic Invertebrate Populations, 42, 44, 52, 79, 121, 135 to 136, 141, 151 to 152, 154, 160 to 163, 195, 210, 216, 221, 226, 259, 273, 278, 283, 293 to 294, 306, 319, 331, 337, 339, 363, 365, 376, 380, 382, 385 to 388, 391, 396, 408, 448, 452, 458, 472, 504, 532, 534 to 537, 539 to 541, 566, 582, 596, 616 to 617, 619, 662, 664, 667, 674, 683, 685, 702, 711 to 712, 714 to 715, 728 to 730, 732, 741 to 745, 748, 772, 774, 782, 817, 833, 854, 857 to 865, 878, 880, 892, 908, 911, 929, 936, 960, 967, 971, 974, 976, 985, 987, 997, 1010, 1019, 1034, 1050, 1061, 1076 to 1077, 1080 to 1084, 1086 to 1087, 1094, 1123, 1186, 1190, 1199, 1204, 1218, 1223, 1260, 1278, 1335, 1349, 1361, 1371, 1377, 1379, 1394 to 1395, 1401 to 1402, 1407, 1410, 1430, 1437, 1441, 1444, 1447, 1479 to 1481, 1483 to 1488, 1498, 1505, 1508

Ash, 98, 435, 845, 1200, 1289, 1344, 1372 to 1374, 1496

Biogeoclimatic Zones, 150, 191, 230, 346, 348, 471, 543, 658, 829, 1270 to 1271, 1312, 1314, 1399

Bridge Construction and Use, 221, 256, 780, 804, 1169 to 1170, 1247, 1379, 1459

Canopy Removal, 3 to 4, 84, 91, 93, 109, 157, 184, 206, 241, 340, 433 to 434, 467, 478 to 479, 506, 520, 600, 624 to 626, 646, 681, 692 to 693, 777, 784, 827, 877, 879, 927 to 928, 940, 944, 986, 1003, 1071, 1074, 1089, 1094, 1102, 1147, 1156, 1163, 1171, 1240 to 1241, 1244, 1267, 1288, 1291 to 1292, 1318 to 1319, 1363, 1415, 1472 to 1473

Catastrophic Disturbance, 14, 92, 516, 587, 845, 943, 1200, 1228, 1344, 1372 to 1374, 1496 to 1497

Channel Alterations, 114, 138, 156, 162, 227 to 228, 240 to 241, 269, 285, 486, 497 to 498, 608, 723 to 724, 975, 978 to 979, 997, 1151, 1156, 1191, 1205, 1221, 1225, 1265, 1274, 1330 to 1331, 1333 to 1334, 1336 to 1337, 1381, 1435, 1452

Channel Morphology, 29, 41, 105, 142, 162, 191, 200, 214, 229, 263, 411, 461 to 462, 497, 509, 525, 546, 566, 574, 608, 633, 637, 723 to 724, 751 to 754, 826, 828, 873, 962, 975, 984, 989, 997, 1135, 1156, 1191, 1205, 1221, 1225, 1274, 1325, 1333 to 1335, 1337, 1353, 1381, 1435

Channelization, 84, 156, 257 to 258, 498, 534, 850, 978 to 979, 1151, 1156, 1169 to 1170, 1447

Chemicals (General), 38, 138, 180, 186, 248, 383, 409 to 410, 583, 662, 664, 667, 691, 697 to 698, 702, 859, 885, 889, 945, 962, 1013, 1023 to 1026, 1028, 1065, 1123, 1183, 1189, 1266, 1287, 1359, 1371, 1379, 1447, 1469, 1500

Conifer Release, 79, 211, 310 to 311, 384, 522, 628, 662, 664, 667, 859, 888, 905, 1122, 1184 to 1186, 1203, 1306

Culvert Construction and Use, 197, 256, 323 to 324, 424, 804, 947, 1135, 1169 to 1170, 1247, 1379, 1459, 1498, 1500

Dissolved Oxygen, 18, 71, 73, 85, 87, 96 to 97, 174, 177 to 180, 192, 275, 287, 293 to 294, 369, 376, 419, 437, 484, 502 504, 513 to 514, 526, 538, 547 to 548, 594, 597, 622, 629, 634, 661, 738 to 739, 751 to 753, 768, 780, 811, 820, 827, 918 to 919, 921, 923, 962, 964 to 965, 969 to 970, 996, 999, 1063, 1065, 1069, 1071, 1076, 1079, 1086, 1099, 1107 to 1108, 1120, 1143, 1151 to 1152, 1180, 1196 to 1197, 1207, 1209, 1215, 1234 to 1235, 1237, 1269 to 1273, 1278, 1289, 1353, 1356 to 1357, 1368, 1414, 1416, 1430, 1442, 1457, 1460, 1463 to 1464, 1466, 1505

Enhanced Temperature Effects, 103, 416, 1180, 1370

Erosion, 1, 5, 33 to 34, 62, 64, 75, 84, 88, 98, 101, 107 to 109, 115, 127, 132, 138, 149, 167, 179 to 181, 185 to 186, 209, 219, 222, 229, 235, 240 to 241, 252 to 253, 260, 264 to 267, 269, 271, 279, 285, 299, 313, 336, 353, 358 to 359, 364, 368, 372, 401, 429, 431, 491, 498, 516, 538, 549, 561 to 563, 574, 583, 592, 608, 634, 661, 663, 665 to 666, 668 to 669, 671 to 672, 681, 684, 709, 779 to 780, 798, 801 to 803, 824, 845, 849,

879, 889, 938 to 939, 941 to 943, 945, 984, 986, 1003, 1036, 1049, 1059 to 1060, 1063 to 1065, 1070, 1098, 1112 to 1113, 1125, 1137 to 1140, 1144, 1147, 1155 to 1156, 1161, 1166 to 1167, 1169 to 1171, 1180, 1192, 1200, 1202, 1214, 1239, 1242, 1247, 1265 to 1267, 1329, 1331, 1338, 1342 to 1345, 1361, 1372 to 1374, 1386 to 1387, 1390, 1417, 1432, 1447, 1464, 1473, 1478, 1489 to 1492, 1494, 1496

Fertilizers, 52, 61, 63, 74, 313, 318, 359, 379, 661, 663, 666, 668 to 669, 671 to 672, 781, 859, 885, 887, 933, 957 to 959, 962, 1026, 1114 to 1118, 1291, 1307, 1372, 1375, 1379

Fire, 14, 92, 158, 179, 277, 313, 359, 516, 575, 587, 646, 703, 827, 844 to 845, 943, 1144, 1200, 1288, 1343 to 1344, 1372 to 1375, 1415, 1496 to 1497

Fire Retardants, 60, 138, 313, 357, 575, 703, 844, 1025 to 1026, 1405

Fish Behaviour and Populations, 2 to 4, 16, 18, 20, 22 to 23, 25 to 27, 36, 38 to 39, 44, 52, 54 to 55, 72, 77, 117, 128 to 129, 131, 134 to 136, 138, 140 to 141, 152, 157, 161, 164, 199, 207 to 208, 218, 220 to 221, 234, 251, 254, 258 to 259, 264 to 266, 302, 306, 308, 322, 349 to 350, 354, 376, 378, 393, 395 to 396, 415, 447, 449, 456, 473 to 474, 476, 482 to 483, 499, 501, 504, 507 to 508, 518, 532, 546, 564, 566, 568 to 570, 574, 576 to 580, 611 to 612, 615 to 616, 619 to 620, 652, 696, 700, 707, 712, 717, 719, 726, 729 to 730, 732, 740 to 744, 748, 750, 773, 780, 782, 789, 792 to 793, 797, 801 to 802, 806 to 808, 812 to 813, 815 to 816, 821, 834 to 836, 838 to 840, 842, 855 to 856, 871, 876, 881 to 882, 886, 890, 895 to 898, 901 to 904, 906, 911 to 912, 915, 919, 925, 947 to 948, 967, 969, 973 to 974, 976, 979 to 980, 982, 985, 987, 990, 997, 1001, 1011, 1015, 1017 to 1018, 1026, 1029 to 1030, 1044, 1046, 1051 to 1053, 1058, 1067, 1072, 1076, 1078, 1085 to 1088, 1094, 1103, 1111, 1113, 1123, 1128 to 1130, 1133, 1148, 1179 to 1180, 1186, 1188 to 1189, 1194, 1198, 1204, 1209, 1212 to 1213, 1217 to 1218, 1224, 1228, 1230, 1246, 1251, 1263 to 1264, 1268, 1275, 1277, 1297 to 1298, 1308, 1313, 1315, 1324, 1335, 1348 to 1349, 1354 to 1355, 1369, 1371, 1377, 1379, 1383, 1394 to 1396, 1401 to 1402, 1405, 1418, 1427, 1430, 1433, 1440, 1445 to 1448, 1470, 1480 to 1481, 1488, 1495, 1498 to 1499, 1508

Fish / Forestry Production Integration, 3 to 5, 29, 43, 46 to 47, 49, 51, 77 to 78, 102 to 103, 110 to 111, 124, 142, 159, 171 to 173, 175, 186 to 187, 189 to 191, 200, 209 to 210, 214, 225, 229, 237, 243, 249, 252 to 253, 280, 304, 307, 356, 362, 371, 411, 416, 423, 425 to 426, 430, 441, 446, 453, 461 to 464, 468 to 470, 504, 506, 525, 530 to 531, 542, 544 to 545, 555, 573 to 574, 621 to 622, 631, 636, 638, 653, 661, 688 to 689, 699, 705, 751 to 754, 775, 785, 798, 800, 805, 828, 846 to 847, 867 to 868, 873, 884, 913 to 914, 917, 922, 929, 952,

987, 1002, 1005, 1009 to 1010, 1049, 1062, 1112, 1135, 1148, 1165, 1169 to 1170, 1173 to 1174, 1180, 1191, 1209, 1219 to 1220, 1247, 1276, 1290, 1309 to 1310, 1321, 1335, 1346, 1382, 1384, 1390, 1430, 1436, 1451, 1474 to 1475, 1478, 1493 to 1494, 1504

Fish Habitat, 3 to 5, 17, 44, 53, 76 to 77, 86, 103, 110, 113 to 114, 116, 126, 131, 133 to 134, 136, 138, 152, 156, 162, 177, 183, 188, 198 to 199, 201, 206, 210, 215, 217 to 218, 220 to 221, 227 to 229, 231 to 235, 237, 241, 247, 251, 256, 258 to 261, 265 to 268, 275, 285, 287, 289 to 290, 298 to 299, 305 to 306, 313, 320, 354, 356, 362, 364 to 365, 375 to 377, 390, 394 to 395, 397, 400 to 401, 407, 426 to 429, 449, 453, 461 to 462, 468, 470, 484, 486, 492, 505 to 506, 512 to 513, 515, 518, 520, 524, 527, 529, 535 to 541, 544, 549 to 550, 564, 566, 569, 574, 584 to 586, 623, 631, 636, 655, 661, 676, 679, 684, 694 to 695, 711, 720 to 722, 726, 738 to 739, 754, 770, 772 to 773, 778 to 780, 784, 795, 798 to 799, 801 to 802, 804, 810, 814, 823, 836 to 837, 853, 875, 891, 913 to 919, 921 to 926, 930 to 932, 934, 937, 946, 969, 973, 980, 987, 990 to 991, 1000, 1005, 1007 to 1008 1014, 1016, 1018, 1026, 1038 to 1039, 1050 to 1053, 1057, 1076, 1078, 1090 to 1093, 1095, 1102 to 1104, 1106, 1113, 1128 to 1130, 1134, 1143, 1151 to 1153, 1155, 1159, 1169 to 1170, 1172, 1179 to 1181, 1188, 1192 to 1193, 1202, 1209, 1212 to 1213, 1215, 1217 to 1225, 1228, 1234 to 1235, 1239, 1243, 1245 to 1247, 1249 to 1253, 1259 to 1260, 1263 to 1264, 1269 to 1275, 1279, 1295, 1308, 1322, 1325, 1330, 1333 to 1337, 1356 to 1358, 1362, 1369 to 1370, 1379, 1388, 1392, 1394 to 1396, 1413, 1433, 1436 to 1437, 1445, 1451, 1459, 1476, 1480

Fish Passage and Water Diversions, 197, 256, 323 to 324, 424, 525, 804, 947, 1135, 1169 to 1170, 1247, 1459, 1500

Fish Production, 15, 17 to 18, 23, 53, 68, 76, 79, 82, 86, 119 to 122, 133, 138, 140, 151 to 153, 201, 211 to 212, 215, 218, 220 to 221, 223 to 224, 227 to 228, 230, 243, 251, 270, 275, 278, 296, 298 to 299, 302, 305 to 306, 316, 325, 327, 337 to 339, 351 to 352, 354, 380, 382, 390 to 392, 394, 397 to 400, 402, 408, 410, 412 to 413, 422, 427 to 428, 439, 456, 472 to 473, 484, 492, 499, 502, 506, 511, 513, 515, 518, 522, 524, 530, 532, 535 to 541, 568, 570 to 571, 574, 579 to 580, 582, 586, 588 to 590, 594, 596, 610, 620, 627, 638, 649 to 651, 679, 691, 702 to 703, 728, 738 to 739, 746, 754, 765 to 766, 769, 771, 774, 778, 786, 795 to 797, 799, 814, 822, 835, 843, 854, 857 to 865, 880, 883, 900, 910, 912, 919 to 921, 923 to 926, 936 to 937, 948, 956, 973, 992, 996, 999 to 1000, 1006, 1015, 1018, 1026, 1030, 1038 to 1039, 1050, 1054, 1078, 1080 to 1084, 1090 to 1093, 1095, 1127, 1143, 1153, 1155, 1172, 1180 to 1181, 1186, 1189, 1191 to 1192, 1194, 1198, 1209, 1212 to 1213, 1215, 1217, 1228 to 1229, 1234 to 1235, 1238 to 1239, 1245 to 1246, 1248, 1253, 1259, 1263 to 1264, 1268, 1270 to 1271, 1276, 1279 to 1281, 1293 to 1294, 1355 to 1358,

1360, 1362, 1369, 1379, 1383, 1396, 1433, 1439 to 1440, 1442, 1445, 1447, 1451, 1465, 1468, 1481

Food Source Abundance, 44, 116, 121, 134, 151 to 152, 163, 221, 273, 278, 316, 319, 337 to 339, 363, 380, 382, 402, 408, 510 to 511, 532, 535 to 537, 539 to 541, 582, 605 to 607, 616 to 617, 662, 664, 667, 711, 746 to 747, 749, 774, 780, 854, 857 to 865, 936, 967, 979, 1054, 1080 to 1084, 1143, 1218, 1318 to 1319, 1388, 1394 to 1395, 1430, 1433, 1437, 1442, 1470, 1479 to 1481

Gravel Restoration, 40, 43, 129, 229, 525, 622, 779, 884, 917, 922, 929, 952, 1135, 1180, 1237

Herbicides, 54, 60, 66, 203 to 204, 216, 248, 310, 313, 334, 343, 359, 361, 383, 391, 405, 410, 436, 440, 447 to 448, 500, 519, 603, 669, 671 to 672, 690, 787, 830, 843, 859, 870, 881 to 882, 885, 905, 935, 962, 981, 1012 to 1013, 1020 to 1023, 1026 to 1027, 1136, 1150, 1157, 1177, 1183, 1189, 1216, 1230, 1291, 1324, 1359, 1379, 1406, 1434

Insecticides, 2, 19, 36 to 37, 39, 50, 55, 60 to 61, 63, 66, 79, 95, 141, 161, 205, 207 to 208, 211 to 212, 248, 254 to 255, 278, 283 to 284, 295, 301 to 303, 308, 311 to 313, 317, 322, 325, 342, 344, 359, 380,383 to 389, 391, 405 to 406, 408, 410, 436, 438 to 439, 456 to 457, 472, 474, 476, 496, 522, 576 to 580, 588 to 590, 605 to 607, 616 to 619, 627 to 628, 635, 654, 661, 663, 666, 668 to 669, 671 to 674, 674, 690, 696, 708, 712, 716 to 719, 728 to 733, 740 to 749, 782, 787, 794, 801 to 802, 821, 825, 841 to 842, 854 to 865, 872, 874, 883, 885, 888, 890, 909 to 911, 948, 954, 962 to 963, 971, 974, 976, 981, 1026, 1058, 1067, 1080 to 1085, 1088, 1096, 1109, 1111, 1114 to 1118, 1122 to 1123, 1126, 1131 to 1132, 1149 to 1150, 1183 to 1186, 1189 to 1190, 1198, 1203 to 1204, 1296 to 1299, 1305 to 1306, 1327 to 1328, 1348 to 1350, 1354 to 1355, 1359, 1377, 1379, 1385,1410 to 1412, 1438, 1446, 1448 to 1450, 1467, 1470, 1488, 1506 to 1508

Instream and Estuarine Habitat, 29, 40 to 41, 87, 103, 105, 114, 129, 142, 190 to 191, 200, 225, 307, 411, 461, 509, 525, 545 to 546, 574, 633, 637, 751 to 753, 820, 826, 828, 868, 929, 952, 966, 975, 989, 1062, 1135, 1148, 1156, 1180, 1191, 1227

Leachates, 71, 83, 85, 87, 96 to 97, 202, 292 to 294, 369, 403 to 404, 415, 484, 493 to 494, 811, 967, 980, 1076, 1086 to 1087, 1195 to 1197, 1206 to 1207, 1209, 1218, 1234 to 1235, 1259 to 1260, 1368, 1394 to 1395, 1430, 1454, 1457, 1505

Leave Strips, 3 to 4, 49, 102 to 103, 124, 134, 138, 157, 159, 170, 172, 177, 188, 225, 233, 269, 304, 307, 336, 368, 371, 416 to 417, 504, 526, 547 to 548, 566, 574, 583 to 584, 621, 631, 663, 668, 691, 773, 800, 869, 913 to 914, 945, 961, 964 to 965, 969 to 970, 987, 1003, 1010, 1175 to 1176, 1180, 1219 to 1220, 1266, 1309 to 1310, 1321, 1346, 1370, 1381, 1400, 1447

Log Booms, 83, 125, 143, 292 to

293, 315, 403, 420 to 421, 452, 493 to 494, 593, 683, 715, 811, 820, 980, 993 to 995, 1008, 1034, 1076, 1195 to 1196, 1206, 1218, 1259 to 1260, 1278, 1282 to 1283, 1368, 1430, 1460, 1505

Log Drives, 21, 125, 281, 292, 403, 675, 967, 1076, 1218, 1311, 1460, 1495

Log Dumps, 83, 87, 143, 292 to 293, 315, 403 to 404, 420 to 421, 452, 683, 715, 1008, 1034, 1076, 1195, 1206, 1218, 1282 to 1283, 1453, 1460

Lumber Preservation, 155, 244, 291, 314, 414, 591, 613, 767, 776, 809, 1097, 1443

Mass Wasting, 24, 65, 67, 98, 127, 167, 179, 222, 229, 253, 259, 261, 264, 267, 279, 427, 429 to 431, 455, 477, 549, 583, 608, 777, 780, 800, 803, 889, 939, 943, 945, 1033, 1036, 1064, 1112 to 1113, 1139, 1144, 1156, 1160 to 1161, 1178, 1180, 1208, 1266, 1329, 1331, 1338, 1342 to 1345, 1382, 1387, 1417

Natural Regeneration, 148, 962, 1285 to 1286, 1326, 1345

New Channel Creation, 110, 525, 1005, 1153

Nutrients, 73, 146, 174, 178, 180 to 181, 192, 304, 366 to 367, 433 to 434, 467, 489 to 490, 510, 513, 516, 547 to 548, 550, 570, 597, 629 to 630, 632, 634, 658, 661, 663, 666, 668 to 672, 678, 737, 768, 787, 827, 830 to 831, 844, 851, 949, 962, 1004, 1065, 1069 to 1070, 1079, 1099 to 1100, 1120, 1196 to 1197, 1209 to 1210, 1261, 1265, 1270 to 1271, 1289, 1291 to 1293, 1318 to 1319, 1332, 1351, 1363, 1373 to 1376, 1414, 1416, 1462, 1464, 1497

Off-channel Habitat, 40, 43, 114, 129, 189, 525, 1062, 1135, 1153, 1180, 1227

Off-channel Ponds, 525

Organic Debris, 42, 44, 49, 57, 76, 86 to 87, 96 to 97, 112 to 113, 116, 123, 125 to 126, 129, 177 to 178, 192, 196, 198, 202, 221, 229, 235, 239, 243, 260, 263, 269, 305, 313, 354, 366 to 367, 378, 404, 429, 431, 449, 453 to 455, 462, 470, 504, 509, 515, 524, 527, 549 to 550, 570, 584, 586, 608 to 609, 661, 663, 666, 668 to 669, 671 to 672, 675, 686 to 687, 721 to 724, 754, 778 to 780, 790, 795 to 796, 799, 801 to 802, 811, 816, 820, 824, 826, 828, 837, 851, 853, 873, 875, 878, 934, 939, 962, 975, 980, 987 to 989, 996, 999, 1004, 1032 to 1033, 1038, 1051 to 1053, 1061, 1068, 1070, 1076, 1099, 1107 to 1108, 1128 to 1130, 1161 to 1162, 1179 to 1180, 1196 to 1197, 1200, 1202, 1205, to 1207, 1209, 1218 to 1221, 1223 to 1227, 1243, 1247, 1259 to 1260, 1269 to 1274, 1278, 1289, 1293, 1308, 1325, 1330, 1332 to 1337, 1344 to 1345, 1361, 1368, 1378 to 1381, 1388 to 1389, 1392, 1396, 1437, 1463, 1482, 1500, 1505

Pulp and Paper Mills, 8, 11, 13, 16, 18, 45, 56, 59, 85, 117 to 118, 120 to 121, 139 to 140, 151 to 153, 160, 165 to 166, 168, 223, 245 to 246, 288, 296 to 297, 309, 321, 326, 328 to 333, 349 to 350, 363, 370, 374, 402, 405, 414, 428, 450, 458 to 459, 482 to 483, 485, 495, 502, 507 to

508, 517, 535 to 537, 581, 610 to 612, 614, 639 to 645, 657, 685, 706, 710, 726 to 727, 734 to 735, 755 to 764, 788 to 789, 791, 801 to 802, 806 to 808, 812 to 813, 817, 819, 822, 834, 838 to 840, 871, 894, 896 to 904, 906 to 908, 950 to 951, 956, 960, 962, 1008, 1017, 1019, 1037, 1040 to 1048, 1054, 1061, 1066, 1072, 1075, 1077, 1079, 1110, 1120 to 1121, 1158 to 1159, 1168, 1198, 1229, 1231 to 1233, 1256 to 1258, 1279 to 1281, 1300 to 1302, 1323, 1360, 1383, 1393, 1397, 1401 to 1404, 1416, 1418 to 1429, 1431, 1439 to 1440, 1442, 1453 to 1457, 1465, 1468 to 1469, 1475 to 1477, 1483 to 1487, 1509

Regional Fish / Forestry Production Differences, 150, 191, 230, 346, 348, 471, 543, 1270 to 1271, 1312, 1314, 1399

Related Fish and Aquatic Information, 17 to 18, 22 to 23, 25 to 27, 37, 68, 95, 122, 135, 143, 151 to 153, 162, 193 to 194, 199, 203 to 205, 215, 220, 231 to 233, 236, 242, 247, 255, 270, 273, 284, 297, 306, 312, 344, 355, 381, 446, 451, 473, 518 to 519, 535 to 537, 564, 568 to 569, 582, 594, 623, 639, 642 to 643, 652, 677, 694, 698, 711 to 712, 755 to 764, 766, 769, 774, 797, 823, 833, 835, 850, 903, 910, 912, 916 to 917, 919 to 921, 923, 926, 930 to 931, 934, 946, 968, 976 to 978, 991, 1000 to 1001, 1006 to 1007, 1014 to 1016, 1018, 1029 to 1030, 1093, 1095, 1103, 1105, 1177, 1183, 1193, 1209, 1217, 1222, 1253 to 1255, 1261, 1263 to 1264, 1282 to 1283, 1317 to 1319, 1356 to 1358, 1362, 1369, 1413, 1432 to 1433, 1435, 1445, 1451, 1466, 1481

Road Construction and Use, 62, 75, 88, 98, 115, 147, 154, 163, 179, 209, 213, 221 to 222, 252, 256, 265 to 267, 336, 340, 358 to 359, 361, 364, 376, 419, 431, 464, 475, 491, 501, 504, 526, 529, 538, 547, 549, 557, 595, 604, 647 to 648, 660 to 669, 671 to 672, 709, 780, 798, 800, 803 to 804, 880, 889, 939, 942, 962, 964 to 965, 969 to 970, 1049, 1059 to 1060, 1063 to 1064, 1102, 1124, 1137 to 1139, 1144 to 1145, 1166 to 1167, 1169 to 1170, 1180, 1239, 1247, 1249, 1270 to 1271, 1343, 1361, 1379, 1386 to 1387, 1417, 1447, 1478, 1489 to 1492, 1498, 1500

Sawdust, 765, 801 to 802, 1453 to 1454, 1456

Sawmills, 765, 801 to 802, 1201

Scarification, 336, 361

Sedimentation, 1, 5, 20, 30 to 31, 35, 60, 62, 64, 75 to 76, 84, 87 to 88, 96 to 101, 104 to 107, 113, 115 to 116, 128 to 129, 133, 135 to 136, 138, 149, 163, 177 to 180, 185 to 186, 192, 195 to 196, 198, 209, 219, 221, 227 to 229, 235, 239, 243, 252, 256, 259 to 260, 264 to 267, 269, 271 to 272, 275, 279, 285 to 287, 298 to 299, 304 to 306, 313, 316, 335 to 336, 341, 353, 358 to 359, 364, 372, 376 to 378, 390, 401, 404, 419, 427, 429, 431, 435, 437, 449, 451, 453 to 454, 460, 462, 498, 504, 510, 513 to 514, 518, 524, 526 to 527, 538 to 541, 544 to 550, 561 to 563, 566, 570, 592, 597, 608, 629, 634, 647, 659, 661, 663, 666, 668 to 669, 671 to 672, 675 to 676, 678, 684, 686 to 687, 691, 694, 709, 722 to 723, 737 to 739,

750 to 754, 768, 770 to 771, 779 to 780, 787, 790, 792 to 793, 795 to 796, 798 to 804, 814 to 816, 820, 824, 826, 836 to 837, 844 to 845, 851, 875, 878, 880, 889, 915, 919, 921, 923, 934, 937 to 939, 941 to 943, 952, 955, 962, 964 to 967, 969 to 970, 975, 982, 985 to 987, 996, 999, 1018, 1031, 1035, 1049, 1051 to 1054, 1059 to 1060, 1063 to 1065, 1069 to 1070, 1073, 1076, 1079, 1090 to 1091, 1095, 1099, 1104, 1106 to 1108, 1113, 1120, 1125, 1128 to 1130, 1137 to 1139, 1143 to 1145, 1147, 1151 to 1152, 1155 to 1156, 1159, 1161 to 1162, 1166 to 1167, 1169 to 1172, 1178 to 1181, 1188, 1192, 1196, 1200, 1202, 1205, 1207, 1209, 1214, 1218, 1223 to 1224, 1227, 1237 to 1239, 1242, 1246 to 1247, 1249 to 1252, 1262 to 1265, 1267, 1269 to 1275, 1278, 1289, 1295, 1308, 1322, 1329, 1331 to 1332, 1335, 1337 to 1338, 1344, 1351, 1353, 1356 to 1357, 1361, 1372 to 1374, 1379 to 1381, 1386 to 1387, 1389, 1394 to 1396, 1408 to 1409, 1414, 1416 to 1417, 1432, 1437, 1441, 1447, 1464, 1471, 1482, 1489 to 1492, 1496, 1498, 1500

Sediment Reduction, 148 to 149, 252

Selective Burning, 14, 98, 132, 179, 181, 361, 428, 435, 566, 737, 819, 962, 997, 1161, 1289, 1351, 1498

Silvicultural Management, 35, 60 to 61, 63, 66, 74, 138, 144, 154, 272, 310, 313, 318, 353, 359 to 361, 428 to 429, 481, 491 to 492, 500, 521, 555, 566, 629, 632, 661, 665, 819, 830, 881 to 882, 887, 893, 933, 940 to 941, 957, 962, 984, 1012 to 1013, 1020 to 1028, 1065, 1114 to 1118, 1172, 1187, 1277, 1299, 1305, 1307, 1320, 1327 to 1328, 1341, 1345, 1350, 1354, 1371, 1373, 1379, 1406, 1488

Site Preparation, 14, 132, 181, 359, 361, 435, 464, 941, 997, 1289, 1373

Skidders, 147, 179, 336, 358, 1167, 1201, 1361

Slash, 57, 60, 98, 313, 434, 454, 1074, 1498

Streamflow, 33 to 35, 74, 80 to 81, 84, 89 to 94, 104, 108 to 109, 126, 131, 134, 137, 154, 173, 176, 179, 221, 224, 227 to 228, 230, 235, 239, 241, 269, 271, 276, 279, 282, 285, 298, 337, 338, 340, 346 to 347, 359 to 360, 366 to 368, 378, 419, 437, 451, 467, 473, 480 to 481, 504, 509, 513 to 514, 526, 534, 551 to 559, 561 to 563, 570, 587, 598 to 602, 623 to 626, 629, 631 to 632, 646, 656, 661, 663, 666, 668 to 672, 687, 692 to 695, 713, 780, 783, 801 to 802, 804, 827, 844, 848, 851 to 852, 877, 880, 893, 924, 937, 940, 944, 962, 964 to 965, 969 to 970, 977, 1007, 1011, 1015, 1069 to 1070, 1073 to 1074, 1079, 1101, 1120, 1141 to 1143, 1146 to 1147, 1161, 1163 to 1164, 1171, 1180, 1188, 1194, 1209 to 1210, 1228, 1262, 1265, 1270 to 1271, 1288, 1292, 1320, 1329, 1333 to 1334, 1336 to 1337, 1339 to 1340, 1344, 1353, 1374, 1391 to 1392, 1394 to 1395, 1408 to 1409, 1414, 1416, 1464, 1472 to 1473, 1496, 1499 to 1500, 1503

Stream Pollution, 15, 38, 64, 82, 119, 138, 140, 143, 147, 151 to 153, 155, 164 to 166, 168, 186, 213, 215, 244, 288, 296, 327 to 332, 343, 355, 363, 405, 407, 409, 414, 436, 448, 460, 535 to 537, 611 to 613, 639, 642 to 643, 652, 702, 822, 953, 956 to 958, 1013, 1021, 1024 to 1025, 1028, 1063, 1065, 1072, 1110, 1125, 1199, 1256 to 1258, 1268, 1282 to 1283, 1287, 1297, 1301, 1316, 1360, 1383, 1401 to 1404, 1418, 1424, 1427, 1431, 1445, 1460, 1468, 1476, 1482 to 1486

Streamside Stabilization, 148 to 149, 200, 217, 544, 736, 913 to 914, 934, 984, 1135, 1187, 1285 to 1286, 1326, 1345, 1392

Streamside Vegetation, 32, 49, 102, 134, 138, 157, 159, 170, 177, 184, 188, 209, 217, 225, 241, 249 to 250, 269, 307, 345, 368, 416, 434, 503, 544, 547 to 548, 566, 584, 621, 631, 655, 681, 694, 736, 773, 798, 810, 875, 879, 913 to 914, 927 to 928, 936, 961, 964 to 965, 969 to 970, 987, 1003, 1010, 1038, 1074, 1099, 1135, 1143, 1154, 1171, 1219 to 1221, 1226, 1265, 1274, 1309, 1321, 1325 to 1326, 1332, 1335, 1345 to 1347, 1370, 1376, 1380 to 1381, 1392, 1447, 1480

Succession and Canopy Regrowth, 200, 1285 to 1286, 1326

Temperature, 17, 20, 32, 36, 60, 73, 96 to 97, 102, 122, 134, 138, 157, 159, 169 to 174, 176, 178 to 180, 182, 184, 192, 217, 221, 225, 235, 240 to 241, 250, 260, 269, 272, 289 to 290, 304, 307, 359, 381, 415 to 416, 419, 437, 451, 478 to 479, 482, 503 to 504, 513 to 514, 526, 546 to 548, 561 to 563, 566, 568, 570 to 572, 574, 587, 597, 621, 629, 655, 661, 663, 666, 668 to 672, 677, 687, 694 to 695, 708, 720, 768, 780, 787, 795 to 796, 799, 801 to 802, 810, 818 to 819, 827, 840, 844, 851, 875, 898, 913 to 914, 927 to 928, 932, 936, 962, 964 to 965, 969 to 970, 987, 997, 1007, 1065, 1069, 1071, 1079, 1099, 1120, 1133, 1143, 1151 to 1152, 1154, 1171, 1175 to 1176, 1180, 1188, 1209, 1219 to 1220, 1240 to 1241, 1244, 1265, 1267, 1270 to 1271, 1274, 1289, 1292, 1309, 1321, 1346 to 1347, 1370, 1394 to 1395, 1414, 1416, 1442, 1445, 1464, 1498 to 1499

Terrestrial Insects, 221, 272 to 273, 532, 595, 774

Timber Harvesting, 3 to 4, 6 to 7, 9 to 10, 12, 20, 24, 28, 31 to 34, 46 to 48, 51, 53, 57 to 58, 61, 63, 70, 72 to 73, 76, 80, 84, 90, 93 to 94, 96 to 98, 108 to 109, 111, 124, 127, 129, 131, 137, 142, 144, 147, 149, 154, 159, 167, 169 to 174, 176 to 188, 191 to 192, 196, 198, 209, 218 to 219, 221, 225, 227 to 229, 234 to 235, 238, 240 to 242, 249 to 251, 253, 257 to 260, 262, 269, 271 to 272, 274, 276, 279 to 280, 282, 285, 300, 304 to 307, 313, 319 to 320, 336 to 338, 347, 351 to 354, 356, 358 to 362, 365, 368, 371, 373, 376, 378, 392 to 393, 396, 398 to 399, 405, 410, 412 to 413, 416, 418 to 419, 422, 427 to 429, 431, 434, 437, 441, 445, 451, 454 to 455, 464, 467 to 468, 478 to 480, 497 to 499, 501, 503

to 505, 511 to 513, 521, 523, 526 to 527, 529 to 530, 533, 538, 542, 547 to 549, 551 to 563, 566, 570 to 572, 574, 583 to 585, 596 to 602, 620 to 621, 629 to 634, 636 to 637, 647 to 651, 661 to 664, 666 to 669, 671 to 672, 679, 681, 686 to 687, 691, 695, 699 to 700, 705, 709, 725, 737 to 739, 754, 768, 772 to 773, 781, 783 to 785, 787, 795 to 796, 798 to 802, 805, 810, 818, 824, 827, 829 to 830, 848, 851 to 852, 866, 875, 879, 895, 913 to 915, 919, 921, 924 to 925, 927 to 928, 932, 939, 943, 945, 947, 961 to 962, 964 to 966, 969 to 970, 972, 983, 985 to 987, 990, 992, 997, 1009 to 1010, 1032, 1036, 1049 to 1053, 1065, 1068 to 1071, 1074, 1078 to 1079, 1094, 1099 to 1101, 1114 to 1118, 1120, 1124, 1127 to 1130, 1134, 1140 to 1141, 1144 to 1146, 1151 to 1152, 1154, 1156, 1163 to 1167, 1169 to 1171, 1179 to 1180, 1202, 1205, 1209, 1211 to 1215, 1236, 1239, 1242, 1244 to 1249, 1251 to 1252, 1254 to 1255, 1265 to 1267, 1270 to 1275, 1289 to 1292, 1294, 1308, 1320 to 1321, 1333, 1335, 1337 to 1340, 1343, 1346 to 1347, 1351, 1361, 1363 to 1367, 1370, 1378 to 1381, 1384, 1391 to 1392, 1394 to 1396, 1398 to 1399, 1414, 1416, 1441, 1444, 1447, 1458, 1479, 1489, 1494, 1498, 1501 to 1504

Transportation and Storage in Water, Log Handling, 21, 83, 87, 271, 292 to 294, 369, 403 to 404, 420 to 421, 493 to 494, 586, 593, 675, 811, 820, 967, 978 to 980, 993 to 995, 1076, 1196 to 1197, 1206 to 1207, 1218, 1259 to 1260, 1278, 1368, 1379, 1430, 1452, 1458, 1505

Transportation and Storage on Land, 221, 271, 891, 1167, 1201, 1379, 1458, 1491

Trucking, 1201, 1417, 1490 to 1491

Vegetation Reclimation, 873

Vegetation Succession, 88, 94, 252, 361, 428, 464, 491 to 492, 632, 893, 984, 1187, 1277, 1285 to 1286, 1320, 1326, 1345, 1378, 1461

Wood Debris Removal, 40, 77, 99, 114, 129, 201, 371, 395 to 396, 429, 633, 636 to 637, 655, 815 to 816, 884, 1180, 1221

Wood Processing, 16, 18, 85, 117 to 118, 120 to 121, 139, 165 to 166, 168, 223, 244, 291, 309, 321, 328 to 332, 349 to 350, 374, 402, 414, 450, 482 to 483, 485, 495, 502, 508, 517, 591, 614, 639 to 643, 645, 657, 704, 706, 767, 776, 789, 791, 801 to 802, 806 to 809, 812 to 813, 834, 838 to 840, 871, 894, 896 to 898, 900 to 902, 904, 906 to 907, 950 to 951, 962, 1017, 1019, 1040 to 1048, 1054, 1061, 1075, 1079, 1097, 1110, 1120, 1158 to 1159, 1198, 1229, 1231, 1401 to 1402, 1416, 1419, 1424, 1427, 1431, 1440, 1442 to 1443, 1457, 1465, 1469, 1475

Wood Waste, 85, 87, 202, 293 to 294, 315, 369, 403 to 404, 453, 484, 714 to 715, 892, 967, 1076, 1087, 1196 to 1197, 1207, 1234 to 1235, 1368, 1430, 1453 to 1454, 1456 to 1457, 1505

Woody Debris Removal, 978, 1153

Woody Debris Stabilization, 114, 131, 148, 200, 574, 633, 637, 934

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